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SOME JAVA P. O. J. SEEDLINGS IN TUCUMÁN AND PORTO RICO *

By ARTHUR H. ROSENFELD, Special Technologist, Insular Experiment Station

Despite the marvelous advances in scientific agriculture in the past quarter century the extension and usefulness of imported varieties of both plants and animals are still frequently as much influenced by popular fancy or caprice as by the actual economic or environmental factors. In the case of varieties of sugar cane, size and appearance, yes, even a characteristic color or mode of growth may exert more influence than their actual productivity or resistance to disease and it appears to the author that we could find no better illustration of this fact than the case of *D–433*, the well-known *Ceniza* cane, which has proven so valuable under the peculiar conditions of Central Fajardo, in Porto Rico. Careful experimentation and years of experience at this progressive central have demonstrated beyond the shadow of a doubt the value of this cane—normally a variety of good tonnage but indifferent sugar content—under the conditions of most of their properties, but this demonstration under limited conditions does not justify the wide distribution of the *D–433* under materially distinct environment of soil and climate. No one will deny, we think, that the good size and ease of identification of this variety, as well as the notoriety it has received from its good record at Fajardo, have been more potent factors in its wide distribution on the Island than results of carefully conducted field trials under the actual conditions of the many other sections into which it has of late years been extended.

With this case in mind, it has occurred to the writer, who has had some fifteen years of experience with a number of the *P. O. J.* seedlings from Java, which have for the time being at least, settled the disease problems of the Argentine sugar district, from where several of them were sent to Porto Rico, that some similar factors

* Paper read at the meeting of the "Association of Sugar Technologists of Porto Rico" held June 14, 1924, at San Juan, P. R.

might have influenced the rather wide distribution of the so-called *Egyptian* cane, *P. O. J. 105* in the sections of the Island most heavily punished by Mosaic Disease, in comparison with others of its sister varieties which in Argentine gave us far better results than the rather striking-looking *P. O. J. 105*, and, at the suggestion of Commissioner of Agriculture Mr. Carlos E. Chardón, an investigation of the comparative behavior of these *P. O. J.* canes in the two countries was begun early this year. The writer has gone rather greatly into detail in considering the Tucumán experiments but feels that a full description of methods and detailed discussion of results in these early experiments are pertinent to the matter in hand, and, given the epoch-making results from these experiments, which, by bringing about a complete change in the basal variety of a whole district, are perhaps unique in Experiment Station history, worthy of rather extended attention.

Climatic Conditions of Tucumán

The province of Tucumán—the smallest and most thickly settled of the Argentine States—lies between the 25th and 26th parallels of south latitude, the cane-growing sections being located at elevations of between three hundred and five hundred metres above sea level. The climate is distinctly subtropical, with all of the changes and surprises that that word implies. The summers are extremely warm, temperatures of above 48 degrees Centigrade in the shade having been recorded, and usually extremely rainy, although there are occasional droughts during the summer season (186)[1]. The usual rainfall is just about one meter annually, which in normal times falls mostly during December, January and February, more than 50 per cent of the annual precipitation occurring in these three months. This is an ideal distribution of a deficient rainfall for cane growing, coming as it does at the time of greatest heat and hence being taken advantage of during exactly the principal time of the development of the cane. The winters are generally cool and rainless—in most years rivalling the famous Mediterranean coast resorts in their brightness and balminess—with a continuous succession of fresh, sunshiny days and nights just cool enough to stimulate rapid ripening of the cane. At times heavy frosts fall, which, depending upon the time of their arrival, do considerable harm to the sugar content and purity of the juices of the cane and also affect

[1] Numbers in parenthesis refer to references in annotated bibliography (Appendix C).

the stand for the following year. This is particularly so if the frosts happen to come in late fall or very early winter and follow upon warm, growing weather.

History of the First Tucumán Experiments

The Tucumán Sugar Experiment Station was established in 1907 by a more than usually progressive government in order to study the causes of the constantly falling-off yields of cane in the province (182). At the time the law was passed it had been evident for several years that the cane was suffering either from some distinct disease or from a general degeneration such as had already occurred in several countries where the same type of cane (*Rayada*) as formed the basis of the Tucumán cane fields had before been generally cultivated. This trouble later proved to be the same now famous Mosaic Disease which was destined within a few years to cause so much consternation and loss here in Porto Rico—and at the same time to give such a decided stimulus to varietal investigations on the Island.

The work of the new Experiment Station, due to the necessity of finding personnel for work under the peculiar conditions of Tucumán—conditions most closely approximated by those of Louisiana—and of obtaining proper apparatus and securing sufficient preliminary data with which to begin serious investigational work, was begun only in 1910. By this time the Mosaic infection was practically 100 per cent all over the Province and it was clearly seen that the most hopeful line of investigation was along that of varietal resistance or immunity, as control measures of any other sort, given the extremely heavy infection, were practically impossible.

In 1910 one hundred and twenty-six varieties of cane were imported for trial under Tucumán conditions directly from the Louisiana Experiment Station at Audubon Park in New Orleans, these canes representing varieties from almost all the well-known cane countries which were then being experimented with in Louisiana, amongst them being various of the better-known Barbados, Demerara and Louisiana seedlings, *Bourbon*, *Caledonia Queen*, *Cavengire*, *Collyns' Seedling*, *Lahaina*, *Rose Bamboo*, *Salangore*, *Tamarín* and *Zwinga* (17). In the same year seventy-six additional varieties were obtained from the Campinas Experiment Station in Brazil and each succeeding year promising canes were imported from other countries, amongst these latter being the Hawaiian

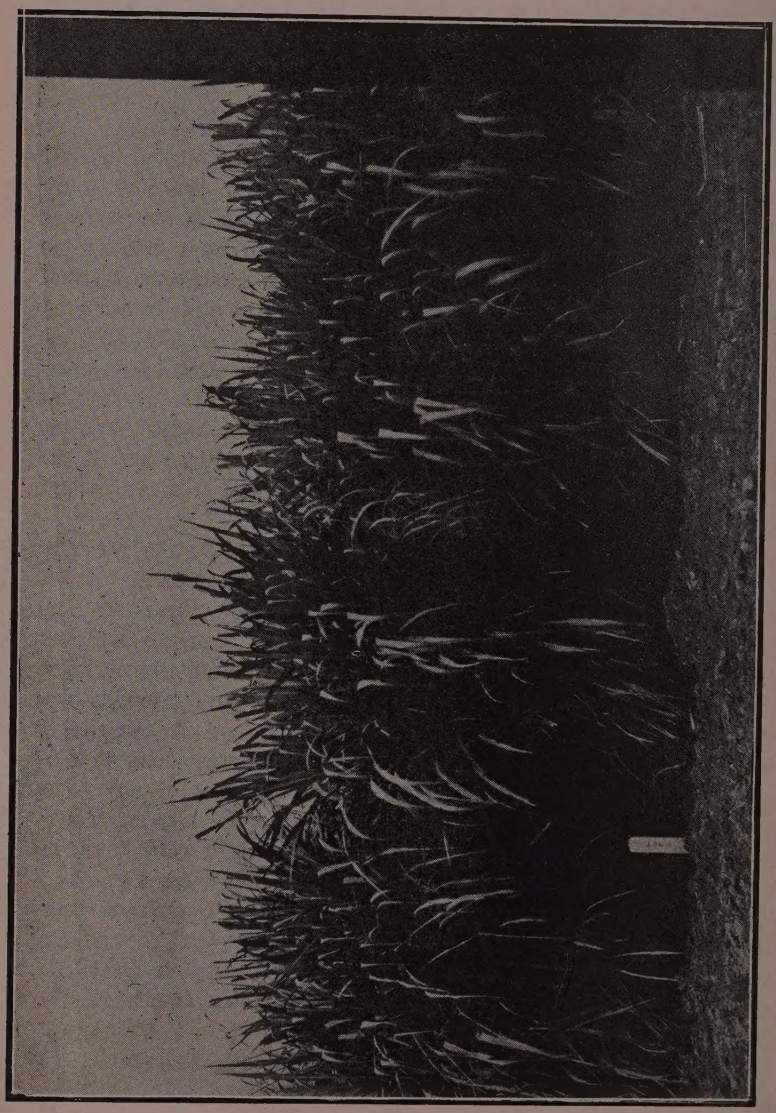

FIG. 1.—One of the two varieties of cane which saved the Argentine Sugar industry. P. O. J. 36 in the Tucuman Agricultural Experiment Station

seedlings Nos. *27*, *146*, *227* and *240* (76). Hence it will be seen that the Java varieties which we are now going to discuss had to compete with canes of well-established merit and not only with the basic canes of the Province.

Six of the *P. O. J.* series of Java seedlings were imported into Tucumán direct from Java in the year 1908, as a result of the law creating the Experiment Station, by then Governor Luis F. Nougués, one of the most progressive and far-seeing officials that Tucumán has ever had, and it is a noteworthy fact that three of these canes—the *P. O. J. 36*, *213* and *234*—so far surpassed all other varieties in agricultural and factory yields under every condition of the Province that within a few years they entirely replaced the commonly planted *Rayada* and *Morada*, and practically all other varieties which had been tried up to that time (194).

While in cultural experiments or in the control of insects or plant diseases the cooperation of the cane growers and, hence, the rapid obtainment of large-scale results is not very easily secured, there is probably no branch of the very diversified work of an Experiment Station in which the public in general takes so keen an interest as that treating of the introduction or breeding of new varieties of plants. Such huge benefits may be obtained in any district through the finding or creation of a new variety of plant which gives notably better results than the varieties actually cultivated in that section and the expense of obtaining this benefit is usually so much less than that incurred in judicious fertilization or for control measures against insects or plant diseases, etc., that the agriculturist follows with much interest any efforts made towards the end of securing him a better variety which will give him larger returns than those he is actually cultivating. This is probably particularly the case in sugar districts, more especially in one like Tucumán, where it was evident when these experiments were started that the variety under cultivation generally at the time was gradually having its yields reduced to absolutely bankrupt figures (184). This fact must be borne in mind in considering the very rapid change of varieties which has come about as the result of the experiments with these new canes.

What points of superiority, then, had we to seek in judging the new canes in comparison with the old standard ones? Leaving aside the question of frost resistance, which is of no interest to us here in Porto Rico, they were four, as follows:

1st. Greater tonnage, with
2nd. Juices containing a higher percentage of crystallizable sugar.
3rd. Greater resistance or immunity to the attacks of Mosaic Disease and other cryptogamic diseases and insects.
4th. The furnishing of more and better fuel as *bagasse*.

Too much time would be occupied were an attempt here made to discuss the various complicated features of our extremely careful system of control of our variety experiments. Suffice it to say that the only variant introduced into these experiments was that of the VARIETY and that differences in agricultural or industrial yield at the time of crop may safely be attributed to differences in characteristics of the varieties themselves. Besides having the varieties on plats as nearly apparently equal throughout their extensions as possible and seeing that every detail of preparation, cultivation, fertilization and harvesting was absolutely identical for all varieties, every individual cane was not only weighed out *counted* it at crop time and the method of obtaining a truly representative sample of each variety for analysis, while too detailed for explanation here, absolutely guaranteed a very true sample.

The experiments were started in 1910, the land selected for the varietal plat under discussion being well plowed with a 26-inch disc plow and harrowed with an ordinary tooth harrow. Rows were indicated with a wooden plow at two metres, then cleaned and deepened with a large double mouldboard plow, the cane being planted in continuous double row the latter part of July, 1910. Three irrigations were given, one each in July, August and September. Fertilizer was applied at the rate of 535 pounds per acre of a mixture consisting of 50 per cent dried blood, 40 per cent superphosphate and 10 per cent of potash. In September the middles were cultivated with a large four-shovel cultivator with the shovels reversed so as to throw the dirt to the middles and the rows were then weeded with spades. In November the middles were cultivated with a light tooth cultivator drawn by one mule and in December a second weeding was given to the rows. Early in January the small cultivator was again sent through the middles, followed, on account of the extremely weedy condition due to recent rains, by a small mouldboard plow. The middle of January the cane was again weeded and early the following month the large cultivator was again sent through, this time with the shovels set to throw dirt to the

rows, the cane being then laid by with spades. Early in March the last cultivation was given with the large middle cultivator, three additional irrigations being then given up to the middle of April 1911. The harvest was made the middle of July, with the results shown in Table I.

Now, as to the first-year stubble—in the middle of September, 1911, the middles were burst out with an ordinary mouldboard plow and the cane off-barred with the same implement with a knife coulter attached. Only one irrigation could be given the first-year ratoons on account of shortage of water, this being at the end of September. Fertilizer was applied as with the plant cane, a little dirt being thrown to the cane when the fertilizer was lightly covered with a small share plow. Early in December the cane was cultivated with the large four-shovel middle cultivator and the six-disc straddling sugar cultivator. About the end of January, 1912, the small tooth cultivator was sent through each middle twice, this completing the cultivation. From this it will be seen that extremely little money was spent on cultivating the stubble cane, no spade or plow work being done after returning the first dirt. The harvest was made early in June, with the results shown in Table I.

As second-, third- and fourth-year stubble, about the same methods were employed as described for the first-year stubble. In September each year the middles were broken out and rows off-barred as already described, this work being followed with one or two irrigations in October, which is usually a very dry month. The second-year stubble was fertilized the first part of November with the same mixture mentioned above, the fertilizer being dropped by hand along each side of the row and lightly covered with a small mouldboard plow. No fertilizer was given the third- and fourth-year stubble or thereafter through ratoons. The latter part of November the large four-shovel cultivator was sent down each middle of the second- and third-year ratoons, while for the fourth-year stubble a Planet Jr. eight-tooth cultivator was employed with good results. In December the rows were given one weeding with spades as second- and fourth-year stubble, but as third-year stubble the Java canes had such a remarkable stand that they were not weeded, only the *Rayada* being thus weeded. This was in 1913 when no frost fell in Tucumán and, therefore, all cane could make its best development. For the lay-by the large straddling six-disc sugar cultivator

FIG. 2.—The so-called "Egyptian" cane, P. O. J. 105, in Tucumán Station

was always employed, the time at which it could be done depending on how early a start the stubble got after crop, the amount of spring rainfall, etc. As second stubble the cane was laid by very early in January, 1913, whereas the third-year stubble got its final lay-by the first part of December of the same year. As fourth-year stubble in 1915 the lay-by was completed the last of December. Usually in January a small tooth cultivator drawn by one mule was sent down the middles, and the second stubble was given an irrigation in January 1913. As third and fourth ratoons the *Rayada* cane, on account of its poorer stooling, was given a weeding in March, but no later weedings were given to the Java canes. Crop in each case was made either in July or August, all results being shown in Table I, which we will now study in detail.

TABLE I

Results from Five Successive Crops from First Planting of Java P. O. J. Canes, Tucumán Agricultural Experiment Station

Analyses and Rendement of Plant Cane (1911) and Four Successive Stubble Crops (1912–1915)

Variety	Metric tons cane per hect.	Average weight stalks Gms.	Chemical analyses of juices					Kgs. of sugar recoverable per hect **
			Brix	Sucrose	Glucose	Purity	Manufg. value *	
P. O. J. 36	34.20	520	17.9	14.5	0.2	81.1	11.76	2815
	76.14	1100	17.0	13.6	0.3	80.0	10.88	5799
	83.40	1101	19.3	16.3	0.2	84.5	13.80	8056
	73.65	730	20.0	17.1	0.2	85.5	14.60	7527
	65.60	680	14.3	11.8	0.9	82.5	9.70	4454
Average.....	66.60	810	17.7	14.7	0.3	83.1	12.20	5687
P. O. J. 213	30.55	340	17.4	14.7	0.1	84.5	12.42	2656
	91.59	790	18.5	15.7	0.1	83.1	11.38	7296
	108.80	690	19.9	17.2	0.3	86.5	14.90	11348
	54.60	580	17.9	14.8	0.3	82.7	12.36	466
	80.80	470	16.6	14.2	0.2	85.5	12.16	6844
Average.....	73.27	580	17.7	14.9	0.2	84.2	12.50	6411
P. O. J. 234	28.85	450	19.5	16.8	0.1	86.2	14.48	2924
	59.50	790	18.1	15.5	0.1	85.7	13.28	5531
	65.20	720	19.7	17.2	0.1	87.3	15.00	6845
	46.65	720	21.6	19.2	0.1	88.9	17.10	5464
	51.85	530	15.5	12.4	0.4	80.0	9.90	3593
Average.....	50.21	640	18.9	16.2	0.2	85.7	13.90	4885
Rayada	21.75	480	16.1	13.2	0.4	82.0	10.82	1647
	27.34	730	16.0	13.8	0.5	86.3	11.91	2279
	34.46	820	17.2	15.2	0.3	88.4	13.40	3232
	17.40	650	20.4	18.4	0.1	90.2	16.60	2022
	14.80	550	15.2	12.2	0.4	80.3	9.80	1015
Average.....	23.15	650	17.0	14.8	0.3	87.1	12.90	2090
P. O. J. average...	63.36	677	18.1	15.3	0.2	84.3	12.90	5661

* Obtained by multiplying per cent sucrose by purity—usual factor in Tucumán.

** Calculated from a basis of 70 per cent extraction of juice on cane.

Taking up first the results from the plant cane, we find that the largest production of sugar per hectare was made by the *P. O. J. 234*, all the analyses, however, being very good for cane cut so early, July in Argentine, of course, corresponding to January here in Porto Rico. All three of the Java varieties gave sugar contents superior to that of the *Rayada*. In tonnage of cane produced the *P. O. J. 36* headed the list, having also the best average weight of stalk. The Java canes produced an average of over one ton more sugar per hectare than did the *Rayada* check plat.

The first thing that strikes us about the results of the first ratoons is the tremendous increase of the yields of the Java varieties over their production of the previous year, both in tonnage and in average weight of stalk. It was this particular comparative increase that made us consider these Java canes so promising and caused us to immediately start large sub-station experiments in all parts of the Province, because in the second year they already appeared to be adapting themselves well to their new environment and conditions of growth, especially when we consider that in their native home cane is grown only as plant. Incidentally, the large sub-stations started in 1912 corroborated the results obtained at the central Station in every respect and were an important factor in diffusing knowledge in regard to these canes and in multiplying the supply of seed then existent (10).

As first stubble the *P. O. J. 213* stands head and shoulders above all the rest, with over ninety tons of cane per hectare and 7¼ tons of sugar and this in comparison with very good yields from the *Rayada*, as Tucumán averages for their native canes went, of over 27 tons of cane and 2¼ tons of sugar per hectare, against a normal average for the Province of about twenty tons of cane and 1⅘ ton of sugar. All of the Java canes more than doubled their yields as plant, the *P. O. J. 213* more than trebling that on previous year, while the *Rayada* increased its yield of cane but 5½ tons and its sugar about three-fifths of a ton per hectare.

As regards the chemical analyses of the juices, the *P. O. J. 234* again leads all the rest, as it did as plant cane. The average production of cane and sugar per hectare of the Java varieties is some 150 per cent higher than the very respectable *Rayada* yield, the average weight of stalk also, contrary to public opinion, due to the thinness of these canes, being slightly superior—that of the *P. O. J. 36* very much higher.

As regards the results of the last three years of stubble, attention should be called to the fact that the years 1913 and 1914 were the two most favorable years ever known for cane growing in the Province of Tucumán, there being abundant rainfall in these years and practically no frost anywhere in the Province. 1915, on the other hand, was a disastrously dry and cold year, breaking all previous records for low yields until 1916 and 1917 each in their turn established new high-frost and low-yield marks.

Table I hardly needs extended discussion, as it very volubly speaks for itself. We need call attention only to the enormous differences in the average yields for five years of the Java and native cane, the latter showing an increase of from 140 to 220 per cent in yield of sugar per hectare under identical conditions of growth and under less expense for cultivation than the *Rayada*. It is also worth noting that the *P. O. J. 234*, while the lowest in tonnage of the Java canes, has given the highest average sucrose content and proven itself a very early maturing variety.

The Second Series of Tucumán Experiments

After obtaining three years' splendid results with these new canes, in sub-stations distributed all over the Province as well as those detailed above in the main Station, we decided to start a special lot of larger scale experiments with these more promising varieties. A piece of land, which had carried alfalfa for two years and was, therefore, in the best of condition for receiving cane, was selected for the experiment. The land was well prepared in July, 1913, and planted in rows 1.66 meters apart instead of at two meters as in the first experiment, the cane being covered with a small mouldboard plow as before. The system of cultivation was practically the same as outlined for the first series of experiments, this latter one being run for three years (one plant crop and two ratoons) or until the check plats, as in the case of the other experiment, had been reduced to such irrisory figures that comparison would no longer have been possible. Incidentally it might be mentioned that the *P. O. J.* canes in this first series of varieties were left to grow and furnish data on their duration as ratoons, of which anon, for as many years as possible after these comparative figures were discontinued on account of the lack of a check and the *P. O. J. 36* and *213* have continued to give splendid yields

FIG. 3.—Another Argentine benefactor. P. O. J. 213 at Experiment Station

through the twelfth year stubble. The thirteenth stubble crop has grown splendidly and will be harvested shortly.

As will be seen from Table III, when the second series of experiments was discontinued the *P. O. J.* canes were still giving very substantial stubble yields and these have continued to date also. No comparative results can be calculated, however, where the check plats have become so depreciated in their yields.

In this second series of experiments an interesting study was made of the germinative potency of the different canes, one of the factors which well explains the success obtained from the Java canes in the Argentine. Beginning about the middle of September, 1913, a count was made each week of the number of sprouts above ground in one row of 100 meters in length of each variety until suckering began in abundance. Table II gives the results of these investigations.

TABLE II

Comparative Germination of the Varieties

Variety	Number of sprouts above ground per row of 100 metres									
	September		October					Nov. 6	Crop. Sept. 1-14	% canes under 10 mos
	18	25	2	9	16	23	30			
P. O. J. 36.....	31	191	325	391	499	574	607	682	1406	51
213.....	62	140	218	238	288	347	361	486	1323	63
234.....	196	331	434	496	543	618	701	856	1315	35
Rayada.....	66	150	186	210	224	270	304	312	564	45
P. O. J. average...	96	222	326	375	443	513	556	675	1348	50

Nothing could illustrate better than this table the strong germinative tendencies of the Java canes as compared with the native. Both in experimental tests and in field observations we have always noted that the *P. O. J. 234*, in common with most high-sugar content and early maturing canes—*B 208*, for instance—is a very quick germinator, whereas the *P. O. J. 213*, particularly in dry seasons, germinates very tardily and seems to make its best growth from the time of coming of the real summer months. Both of these tendencies are very well shown by the table. On September 18th the *P. O. J. 234* had three times as many sprouts per row as its closest rival—the *Rayada*—and on the 9th of October still had twice as many sprouts as the *P. O. J. 213*, but, nevertheless, at crop time the *P. O. J. 213*, which had suckered vigorously after November, had matured more stalks per row than the *P. O. J. 234*—stalks, by the way, with greater average weight by 190 grams. Another interesting comparison is that between the *P. O. J. 213* and *36*, the

latter variety which we have always found to be a quicker germinator than the former. On the 18th of September the *P. O. J. 36* had just exactly half the number of sprouts per row as the *P. O. J. 213;* nevertheless, just one week later the *P. O. J. 36* had 51 sprouts more than the *P. O. J. 213* and at the time of the last count on the 6th of November, the *P. O. J. 36* had almost 200 sprouts per 100 meter row more than the *P. O. J. 213.*

Another interesting point which this table brings out is that when we talk of twelve- or fourteen- or sixteen-month cane, we are not describing by any means exactly the average age of the canes we are sending to the mills. Of the *P. O. J. 213* cut at the harvest of these plant canes on the 1st of September, 63 per cent had started growth after the first week in November and, hence, had a maximum growth of but ten months. Over half of the stalks of the *P. O. J. 36* germinated after the first week of November, about one-third of the *P. O. J. 234* and almost half of the *Rayada.* An interesting field of research along this line remains open in studies of our varieties—some attempt to define exactly what the terms "fifteen-month" or "eighteen-month" cane mean, give some idea of how old the average cane really is at these different ages with the distinct varieties.

An examination of the results of three crops from this plantation, *i. e.*, the plant cane of 1914 and the first and second ratoons of 1915 and 1916, respectively, the latter two disastrously unfavorable crops for all Tucumán cane, shows us (Table III) that in this series of experiments the comparative results of the Java varieties and the native cane are even more striking than in the former series. So evident it this superiority that comment on the table is is unnecessary, hence we can turn our attention for a moment to Table IV, giving the average results for the eight crops from the plantings.

TABLE III

Results from Three Successive Crops from Second Planting of Java P. O. J. Canes, Tucumán (Argentina) Agricultural Experiment Station

[Top lines represent plant cane (1914), middle lines first stubble and bottom lines second-stubble (1916)]

Variety	Metric tons cane per hect.	Average weight per stalk Gms.	Chemical analyses of juices					Kgs. of sugar recoverable per hect.
			Brix	Sucrose	Glucose	Purity	Manufg. value	
P. O. J. 36	87.72	1040	17.3	14.0	0.6	80.0	11.30	6939
	101.58	900	16.1	12.4	0.8	77.0	9.50	6755
	36.15	700	17.1	13.6	1.2	79.5	10.80	6512
Average.....	91.82	880	16.8	13.3	0.9	78.8	10.53	6735
P. O. J. 213	59.46	750	18.5	13.0	2.1	70.5	9.20	3829
	10.36	490	14.5	11.4	0.6	78.6	9.00	3803
	64.88	480	14.7	11.9	0.7	81.0	9.60	4360
Average.....	61.57	573	15.9	12.1	1.1	76.7	9.27	3997
P. O. J. 234	43.80	560	17.0	13.6	0.2	80.0	10.90	3342
	44.16	540	15.4	12.0	0.3	77.9	9.30	2875
	41.27	480	15.8	12.8	0.6	81.0	10.40	3004
Average.....	43.08	527	16.1	12.8	0.4	79.6	10.20	3074
Rayada	20.76	610	17.6	14.1	0.2	84.1	12.4	1802
	26 40	590	13.6	10.1	1.0	74.3	7.5	1386
	17.05	410	12.9	8.8	1.9	68.2	6.0	716
Average.....	21.40	537	14.7	11.0	1.0	75.5	8.6	1301
P. O. J. average...	65.49	660	16.3	12.7	0.8	78.4	10.0	4602

TABLE IV

Average of Results of Eight Crops from Two Plantings *

P. O. J. 36.	76.05	840	17.4	14.2	0.5	81.6	11.6	6176
P. O. J. 213.....	68.88	580	17.0	13.9	0.5	81.8	11.4	5497
P. O. J. 234.....	47.53	600	17.8	14.9	0.3	83.7	12.5	4159
Rayada.....	22.49	610	16.1	13.4	0.6	83.4	11.2	1764
P. O. J. average...	61.15	673	17.4	14.3	0.4	82.4	11.8	5277

* All averages in these tables are obtained by adding together the figures for the various years and dividing by the number of years represented, instead of calculating values from the average figures, as for instance, average purity from av. brix divided into av. sucrose.

We find that the *P. O. J. 36* heads the list of varieties, with the splendid average yield for Tucumán of more than 75 tons of cane and 6 tons of sugar per hectare, in comparison with 22½ tons of sugar for the native—a yield, be it remembered, above the average for the *Rayada* in Tucumán in good years. The average chemical analysis of the *P. O. J. 36*, results better than the native. The yield and analysis of the *P. O. J. 213* is very close to that of the *P. O. J.*

FIG. 4.—The sweetest of the P. O. J. canes—234—in one of the variety plats of the Tucumán Experiment Station

36 and still more than three times the native yield. The juice of the *P. O. J. 234* has maintained its position throughout the test as the richest of all of the varieties and in yield of both cane and sugar per hectare it has exceeded the native *Rayada* by well over 100 per cent.

Definitive Recommendation and Extension of the P. O. J. Canes

After such a long series of experiments and demonstrations in all parts of the Province, during which the most promising varieties had been multiplied in strategic locations so that large-scale planting was immediately practicable, no further doubt could exist as to the superiority of these three *P. O. J.* canes over the native *Rayada* and the other canes tried under Tucumán conditions (69). At the Experimental Station and in the sub-stations, some of which were very large observation fields, we had by 1916 six full years of experience with the new canes under every climatic condition conceivable for Tucumán. The results showed an average yield in cane and sugar per hectare of the three *P. O. J.* canes we have been considering of just about three times that of the *Rayada* yields during the same period and under identical conditions throughout and these results had been confirmed by the large planting of several of the more progressive and wide-awake centrals. The time had come, therefore, for the Experiment Station to make definite recommendations of these canes for supplanting the native striped and purple ones. Early in 1915 an active propaganda was commenced and was duly continued for several years until the planter, large and small, had been induced to leave off the expensive cultivation of the sorely weakened native canes and supplant them as rapidly as possible with the vigorous, rapid-growing Java ones, following the counsels of the Experiment Station officials as to the best of the Java varieties for their particular conditions of abundance or lack of irrigation water, type of soil, etc., etc. With the crop of 1915 practically a complete failure, then—in that year the Province produced less than half of the 263,000 tons of sugar turned out the previous year—the more progressive planters of Tucumán at last put their prejudices and sentiments into their pockets and began to plant the new canes most vigorously, many of them paying enormous prices for seed cane to the still more progressive men who already had large plantings of these varieties established. Some of these latter men made fortunes through their longheadedness. When in 1916 the

FIG. 5.—A stool of P. O. J. 36 in Tucumán Experiment Station

average yield of native cane dropped to only about eight tons per hectare, the prejudices against these foreign invaders of their cane fields almost entirely disappeared and some fifty thousand acres of these canes were laid down, the *P. O. J. 213*, as an all-round cane, predominating. The comparatively good development of these plantings in the unprecedentedly unfavorable season of 1916–17, when the native canes, due first to frost and then to drought, practically did not make any growth at all, was the straw that broke the proverbial camel's back and in 1917 everybody fell over themselves to secure seed of the Java varieties, paying almost any price asked by the more fortunate possessors of *P. O. J.* canes, prices of twice the ordinary factory price being paid for seed in train-load quantities with the greatest cheerfulness. It is probable that another sixty thousand acres were planted in 1917, which figure was very little added to in 1918, due to the frosts being so early and so heavy that extremely little good seed was available (105). In 1919 and 1920 the substitution of the Java canes, principally *P. O. J. 36* and *213*, the *P. O. J. 234* being used only for early grinding, since it does not compare with the other two varieties in field tonnage, went merrily on, the last official statistics in 1923 putting the amount of native cane remaining in the Province at 864 acres against 203,162 acres of the Java canes—a replacement of about 99½ per cent. Indeed, today the native canes, as the writer predicted in an address in Buenos Aires six years ago (182), are looked on as curiosities when an occasional specimen reaches the mills, practically always mixed in with cars of *P. O. J.* canes. Such is the blooddless revolution which has taken place in the "Garden of the Argentine Republic" in the comparatively small space of time of less than one decade.

An idea of the magnitude of the reconstruction on some of the centrals which had given no attention to the Java varieties before the disastrous crop of 1915 may be gained from the writer's experience at the Santa Ana estates, the largest in the Province and probably in South America, to take charge of which he resigned the directorship of the Tucumán Experiment Station during the crop of 1916 (27). For that crop the Ingenio Santa Ana had some fifteen thousand acres of cane, not one stalk of which was of the Java varieties. In the following two years we entirely renovated these huge plantations with the Java varieties, and for the crop of 1918 there was not a single stalk of native cane on the entire place.

Incidentally, some of the results obtained from these plantings may be pertinent to this discussion and will be found in Table V. The results from these thirty-five fields represent cane harvested from some one thousand acres during the crop of 1919, a year of serious early frosts, and, hence, of low sugar contents and purities in general, as will be noted in Table V. All fields were ratoons (192.)

TABLE V

Detailed Results of Stubble of Java Canes from 1,000 Acres

Ingenio Santa Ana, Tucumán Province

Field	Met. tons per hect.	Brix	Sucrose	Purity	Manfg. value	Ks. sugar per hect.
			I.—P. O. J. 36			
1	77.90	16.7	12.94	76.5	9.90	5,398
2	35.40	16.8	13.61	81.0	11.02	2,731
3	45.45	15.5	11.25	72.5	8.16	2.596
4	55.15	16.3	12.76	78.2	9.98	3,853
5	54.30	14.4	10.97	76.1	8.35	3,173
6	52.40	16.0	12.62	78.9	9.96	3.655
7	68.25	14.0	9.50	67.7	6.43	3,072
8	60.20	12.9	10.94	84.8	9.28	3,841
9	60.20	13.2	9.14	69.2	6.32	2,616
10	46.55	13.6	9.20	67.6	6.22	2,027
11	59.25	15.2	11.78	77.5	9.18	3,787
12	57.55	13.5	8.88	65.7	5.95	2,397
13	52.95	14.5	10.25	70.8	7.26	2,691
14	43.75	16.7	12.86	77.0	9.90	3,039
15	60.25	16.5	12.74	77.2	9.84	4,150
16	58.45	18.6	13.26	71.2	9.44	3,862
17	63.65	17.2	14.15	82.2	11.63	5,182
18	52.20	13.8	9.20	66.5	6.12	2,236
19	57.35	16.2	11.27	69.5	7.83	3,143
20	75.20	14.2	8.63	60.7	5.24	2,758
21	73.10	16.1	12.18	75.6	9.21	4.713
22	71.80	16.1	12.55	77.9	9.78	4.915
Average	58.21	15.4	11.39	78.8	8.50	3,447
			II.—P. O. J. 213			
1	39.85	14.4	11.56	80.1	9.26	2,583
2	71.95	16.3	13.69	83.9	11.49	5,787
3	51.80	15.2	11.83	77.6	9.18	3.329
4	54.50	16.1	12.20	75.7	9.24	3.525
5	54 15	16.6	13.05	78.6	10.26	3.889
6	38.00	12.9	8.71	67.8	5.91	1.572
7	51.40	13.5	9.38	69.3	6.51	2,342
8	59.85	13.8	9.22	66.5	6.13	2.568
9	55.55	16.0	11.44	71.5	8.18	3.181
10	58.85	16.3	12.45	76.3	9.50	3.916
11	55.45	14.2	10.82	76.1	8.23	3.194
12	62.35	15.5	12.38	79.9	9 89	4,316
13	44.25	15.9	12.75	80.4	10.25	3,175
Average	53.70	15.1	11.48	75.7	8.77	3,337

These results may be taken as fairly accurately representing the comparative value of the *P. O. J. 36* and *213* all over the Argentine sugar district today, the *P. O. J. 36*, on account of its larger

FIG. 6.—P. O. J. 213 on new land at Ingenio Santa Ana, Argentina. This cane is just five months old from planting

diameter and easier stripping, as well as its erectness, having gradually come to occupy first place in the preferences of the planters, although a much larger proportional area of the *P. O. J. 213* was at first laid down, while the *P. O. J.* 234, though an early maturer, is now generally recognized as being a much more delicate cane in every sense than its sister varieties and, hence, over a long series of years, giving a much lighter average yield. *P. O. J.* 234, however, does have the advantage of being a very quick germinater and an erect, rapid grower and, although it has the decided defect of forming numerous adventitious roots, it does not have the drawback of lodging so characteristic of the *P. O. J. 213*, though not of the *P. O. J. 36*. This tendency to lay over, particularly after heavy rains, is one of the few serious points which can be advanced against the *P. O. J. 213*. The *P. O. J. 36* is also rather a quickly germinating variety, but in average richness of juice it is probably slightly inferior to the *P. O. J. 213*, although under normally favorable conditions it can generally be counted upon to offset this condition by giving around a ten per cent better agricultural yield.

Under distinctly unfavorable conditions of any sort, however, neither of the other two varieties mentioned can compare with the *P. O. J. 213* as an all-round cane and for this reason the Argentine planters will do well to always maintain at least half of their plantations in this variety. Under severe drought conditions it is a very slow germinater, but even under the most extreme of such conditions it will not dry out and perish entirely as the *P. O. J. 36* or *234* and with the first rains is up and away as few other canes that the writer has observed.

As regards distinctly unfavorable conditions, the writer has had one experience with hail that he is not likely to forget and which illustrates nicely the extreme resistance of the *P. O. J. 213* to the most unfavorable of conditions. On the 17th of December, 1919, about one-third of the plantations of the Santa Ana estate, which were then almost ready for the lay-by, were swept away by a hail storm such as the author hopes never again to have the misfortune to witness. The hail lasted exactly twenty-two and a half minutes in the center of the storm and was accompanied by a sixty-mile wind—a veritable tornado—the enormous hail stones coming along almost horizontally and with such force as to leave all brick and concrete walls and even *quebracho* fence posts with southern exposure as pitted as if they had been fired into with machine guns.

After the piled-up hailstones melted, which was not for six or seven hours in the open fields, *although the maximum temperature that day was 105 degrees Farenheit in the shade,* not a cane stool could be seen standing erect, and two or three days afterwards the entire belt which had been scourged by the hail looked exactly as though a prairie fire had swept over it, leaving not a vestige of green in its wake. Neverthless, with only four months, growth, the *P. O. J. 213* in this zone re-erected itself as if nothing had happened and in the crop of 1920 gave us an average yield of about fifteen tons of cane per hectare, whereas the *P. O. J. 36* did not produce fifty per cent of that quantity. Incidentally, we might state that the stubble of the *P. O. J. 213* recovered perfectly and gave splendid yields again in the next and following crops, while that of the *P. O. J. 36* needed a great deal of replanting to restore it to anything like its original productiveness. Of course this is a very extreme case which is not likely soon, if ever, to be repeated, but all of these points should be carefully borne in mind by the planter who is selecting the basis for his future plantations.

In the Argentine the writer advised the use of the *P. O. J. 213* for very early and very late harvesting and the *P. O. J. 36* in the middle months.

Duration of the P. O. J. Canes as Ratoons

In our opening remarks in regard to the second series of Tucumán experiments, we mentioned the fact that the stronger ratooning canes, such as the *P. O. J.* seedlings and the *Uba*, which were planted in 1910 in the first experiment which we have discussed with these canes, were left growing after the original experiment had to be discontinued on account of the check plats having practically run out, in order to obtain some data as to the probable duration of stubble crops from these stronger varieties. The results of thirteen successive harvests from this original planting—one of plant and twelve of stubble—have recently been published (81) and the data furnish material for an interesting study of the remarkable "sticking power" of the *P. O. J. 36* and *213* under Tucumán conditions—this, be it noted, despite the very large number and intensity of the frosts which have fallen in the province during this long period and despite a 100 per cent Mosaic infection from the planting of the original seed. It should be noted, also, that these results are made all the more striking by the fact that the original planting

FIG. 7.—First ratoons of the P. O. J. 213 at five months. Ingenio Santa Ana

has never been replanted even to the extent of filling in a single lost stool, nor has this plat received any special cultivation or fertilization—in fact the amount of both have been almost an irreducible minimum. In view of these facts we are inclined to think that the records from this experiment are decidedly unique and that there is little data anywhere covering the yields and manufacturing value of so many successive crops from one original plantation and without any replanting. The writer has run across canefields in various parts of the word whose proud owners claimed that they were fifteen, twenty or even twenty-five years old, but investigation generally revealed the fact that more or less extensive replanting had been done each year or two and it is highly probable that little of the original plantation remained. Most of these cases, in our opinion, are comparable to the case of the man who dilates on the fact that he has had his Ford car for ten years and that it is still "as good as new". It probably is as perfect as the original purchase, but it is also probable that, with the many repairs and replacements, very little of the original car remains besides the radiator cap or the switch key!

In order to avoid a redundance of data, which has already grown rather voluminous, we give in Table VI only the results of the tenth, eleventh and twelfth stubble crops, made at the end of August 1921 and 1922 and early in July in 1923.

TABLE VI

Results from Tenth, Eleventh and Twelfth Stubble Crops from Original Plantings of Java P. O. J. Canes, Tucumán Agricultural Experiment Station

CROPS OF 1921, 1922 AND 1923

Variety	Tons cane per hectare	Average weight per stalk Grams	Chemical analyses of juices			Recoverable sucrose per hect. ks.
			Brix	Sucrose	Purity	
P. O. J. 36	58.50	520	17.39	15.13	87.00	5800
	57.25	580	19.32	17.02	88.09	6450
	55.00	570	19.73	17.02	86.22	6100
Average	56.92	557	18.81	16.39	87.10	6117
P. O. J. 213	32.00	370	17.74	15.39	86.75	3200
	92.50	470	19.72	17.51	88.79	10700
	56.00	460	20.60	18.43	89.46	6800
Average	60.17	433	19.35	17.11	88.33	6900
P. O. J. 234	23.50	470	16.39	14.17	86.45	2200
	22.50	500	20.30	18.26	89.95	2750
	28.00	480	20.25	16.73	82.61	3000
Average	24.67	483	18.98	16.39	86.34	2650

TABLE VII

Results from Third, Fourth and Fifth Stubble Crops from Native Striped and Purple Cane Well Cultivated, Tucumán Agricultural Experiment Station

CROPS OF 1921, 1922 AND 1923

Manured	Tons cane per hectare	Average weight per stalk Grams	Chemical analyses of juices			Recoverable sucrose per hect. ks.
			Brix	Sucrose	Purity	
No	23.87	460	16.67	14.48	86.86	2273
Yes	22.93	460	17.05	14.87	87.21	2246
No	19.80	480	15.59	12.84	82.36	1626
Yes	19.47	530	15.10	12.21	80.86	1505
No	15.87	400	17.98	15.66	87.09	1637
Yes	12.67	390	17.45	15.08	86.41	1253
	19.10	453	16.64	14.19	85.13	1757

A glance at Table VI and a comparison of it with Table I show us that *P. O. J. 36* and *213* have maintained their high standards of production in these very old stubble crops, while the *P. O. J. 231* has dropped very materially in its average yield, in accordance with its earlier record as not such a vigorous cane in any respect as the other two here studied. There will also be noted with all of the three canes a very natural tendency, on account of their remarkable ratooning power, of having a slightly lower average weight of stalk as the ratoons get older. On the other hand the sucrose content and purity of the *P. O. J. 36* and *213* tend to rise directly with the age of the ratoons.

It is difficult to find, therefore, the economical limit of stubble cane for the *P. O. J. 36* and *213* in Tucumán. Undoubtedly it is a poor agricultural practice to leave one crop on the same land for so long a period, but we think it is hardly probable that the average planter would be content to plow out this stubble, even at the age of fifteen years while it continues to give him such substantial and profitable yields with a minimum expense of cultivation, the *P. O. J. 36* and *213* as stubble closing so rapidly that very little cultivation is possible. On the whole, we gather from Table VI that the average results from the last three stubble crops of these canes are slightly better in yield of both cane and sugar per hectare in the case of the *P. O. J. 213* than in that of the *P. O. J. 36*, although the former is susceptible to much wider fluctuations in yield in distinct years than the *P. O. J. 36*.

On the same page with Table VI are given for comparison in

Table VII the results from the third, fourth and fifth stubble crops of native striped and purple cane harvested the same years as the tenth, eleventh, and twelfth ratoon crops of the *P. O. J.* varieties with the results shown in Table VI. A comparison of the average results in the two tables shows how utterly inferior in every respect are the results from these stubble crops from the native cane to these obtained from the *P. O. J.* varieties from infinitely older stubble, although the native cane constituted a series of plats used for testing the value of the native cane UNDER OPTIMUM CONDITIONS.

Cross (85) in 1917 started these experiments with the object of determining if it could be made to give satisfactory yields by employing the best of cultivation methods, heavy fertilization with stable manure, etc., and the giving of the longest possible growing season by late harvesting in years of little frost. As stubble alternate plats were fertilized each year with an application of stable manure at the rate of thirteen tons per hectare. As will be seen from Table VII, the effect of the manure was *nil*, since the unmanured cane gave slightly more cane and sugar per hectare than the manured plats, nor was there any appreciable effect of the manuring on the average weight of the stalks. Of this Cross says:

> "This confirms the results obtained by the Experiment Station in similar experiments from 1910 to 1915 (175) which indicated that the native cane, degenerated from the attacks of Mosaic Disease, does not respond to manuring."

VALUE OF THE P. O. J. CANES TO THE ARGENTINE INDUSTRY

We may safely say, then, that several of the *P. O. J.* canes—*36* and *213* in particular—have saved the Argentine sugar industry from absolute bankruptcy, for no industry could resist the enormous losses which would have had to be sustained had Tucumán not had within its reach the salvation from the ridiculous yields to which its native canes had fallen—if she had not found the remedy ALREADY WAITING FOR HER when ruin was staring her in the face. It is probable that there is not a case in the history of Experiment Stations—and there are some remarkable chapters in that history—where one of the principal industries of an entire section has been so rapidly reconstructed and entirely saved in the short space of seven or eight years.

There is a very common tendency in certain quarters to look upon the work of an experiment station as something extremely and luxuriously theoretical—as interesting, yes, but of slight *practi-*

cal importance. We think that the work of the Tucumán Experiment Station which we have just been discussing may well be used as evidence in refuting any such charge. Let us see, for example, what this one series of varietal investigations alone may mean in dollars and cents in simply the saving in annual expenditures of the Tucumán planters. And the figures here given are not theoretical ones, but are based on the actual costs from thousands of acres of the two distinct types of cane from the time of planting to that of harvest. It is generally conceded in Tucumán that the native cane, year in and year out, costs for cultivation just about twenty dollars per acre—in fact this was for decades the amount universally advanced by the factories to their *colonos* and *cañeros*. The average yield for the native (*Rayada*) *cane, before the last series of disastrous years,* was but a little over eight tons per acre. That means, therefore, that the cost of cultivation of the *Rayada* cane PER TON was about $2.25. We have seen that the *P. O. J.* canes are quicker growing and, hence, need less weeding and general cultivation, while yielding from twice to four times as much as the native cane. Let us take as a conservative figure only twice the yield of the native cane and assume that we will spend 80 per cent as much in cultivation per acre, a figure which should never be realized, as the Java canes are actually cultivated at a much lower rate than this. This means, then, reduced to *cost per ton,* that the Java canes cost for cultivation a little under one dollar per ton, whereas the Tucumán planters have been in the habit of spending $2.25 on the native cane. The Tucumán planters, then, are today saving in cost of cultivation at least $1.25 on every ton of cane they deliver to the factories. In her last crop the Province of Tucumán ground slightly over three million tons of cane, which would work out at an annual saving of over three and three quarter millions of dollars in cost of cultivation of the area required to produce this amount of the *Rayada* cane even were it possible to produce it—and the annual cost of the Experiment Station to the Province has been about 1 per cent of this amount!

THE SO-CALLED EGYPTIAN CANE—P. O. J. 105

P. O. J. 105, one of the same series of canes which we have been discussing, all produced by crosses of *Cheribón* (our Porto Rican *Rayada* is the *Striped Cheribón*) and *Chunnee* by Kobus in Java, was introduced into Egypt many years ago by the Societé Générale des Sucreries d'Egipte, which company holds practically the mo-

nopoly of the Egyptian sugar industry, and is by no means, as has been more or less commonly thought, indigenous to that country.

Under date of 10th of May, 1913, the Societé Générale des Sucreries in a letter to Messrs. Hileret & Co., owners of the "Santa Ana" estates in Tucumán, gave us the following information about this variety:

"It is remarkable for its elevated production and its surprising rusticity, which resists better than any other the fluctuations of climate and irrigation. Foliage abundant, sugar content generally equivalent to that of the *'rubanée du pays', i. e.,* between 13 and 14½ per cent, but its maturity is generally one or two points lower. Nevertheless it will produce an amount of extractable sugar per hectare superior by 30 to 60 per cent to the other varieties here. We can easily obtain with the *P. O. J. 105* a yield of 115 tons of cane per hectare, with 10 to 10.25 per cent white sugar bagged, in spite of the fact that in Egypt we have but an eight-month growing season.

"Its defects are, (1) quick inversion after cutting, which means organization for quick deliveries and grinding, and (2) greater difficulty in stripping than with the other varieties. However, we consider that its advantages considerably outweigh its defects."

About this time this variety was introduced, as "Ambar de Egipto", into the Province of Tucumán by the Nougués Brothers, propietors of the San Pablo factory and plantations, and the material for trial at the Sugar Experiment Station of Tucumán was obtained from those gentlemen. In the characteristics of this cane we find much in common with the other canes of this series, as it is a tall-growing, thin type of cane of vigorous development and high ratooning qualities. In Tucumán and in Egypt the characteristic stalk color is amber, a color quite common in the younger canes here in Porto Rico, but after the older canes have suffered exposure to the sun they become a rose color somewhat similar to that of *P. O. J. 36,* although quite a number of stalks are found of a green shade very similar to that of the *P. O. J. 231,* with both of which canes this variety is sometimes confused. The buds, however, are quite distinct for the three varieties, as may be seen from a study of the illustration of the same in this publication. Generally the stalks are rather heavily coated with wax in the *P. O. J. 105.*

In the first few years after its introduction the *P. O. J. 105* received a great deal of attention from planters in the Province of Tucumán, Nougués Brothers very rapidly extended their acreage—as, incidentally, they had previously done with the *P. O. J. 100,* only to have to destroy it later on when it was found that it suffered very severely from Mosaic attack—reporting lower fibre

content and higher percentage of sugar for the *P. O. J. 105* than for other *P. O. J.* canes, and requests to the Experiment Station for seed were many and beseeching. The fond hopes founded on this cane, however, were never justified in Argentina, for, while careful experimentation at the Station proved it to have many very excellent qualities, it never made a showing which would permit it to compete very seriously there with either the *P. O. J. 36* or *213*.

When the writer left the Argentine, Nougués Brothers, in spite of our rather indifferent results with *P. O. J. 105* at the Experiment Station, were still multiplying their plantings of this variety, and a number of other factories and planters were following suit in a minor degree. The writer recently wrote to Dr. W. E. Cross, who succeeded him as Director of the Experiment Station and to whom he wishes to express his appreciation of the valuable information furnished him for this paper, requesting data upon the plantings of the *P. O. J. 105* at San Pablo and other places where this variety was rather popular several years ago. Dr. Cross was kind enough to send us a letter which he had received in answer to his inquiry from Engineer José Padilla, Manager of Ingenio San Pablo, in which he states that "We have been obliged to replace it with *P. O. J. 36* and *213* to such an extent that we now have only about ten hectares of the *P. O. J. 105* left on our estates."

We received the *P. O. J. 105* at the Tucumán Experiment Station in 1914 and observations on it have been made constantly since that time. It was planted in three distinct lots in 1914, 1916 and 1917, the results of which Cross has recently published. We give below the results of second, third and fourth ratoons, from the crops of 1919, 1920 and 1921, as Table VIII, a comparison of which with Tables I, III and VI will demonstrate that, while this variety has given satisfactory cultural results, it is decidedly inferior to the other *P. O. J.* canes.

TABLE VIII

P. O. J. 105 in Tucumán

[Second-year stubble on first line (1919), third and fourth year successively]

Metric tons cane per hect.	Average weight stalks Gms.	Chemical analyses of juices					Kgs. of sugar recoverable per hectare
		Brix	Sucrose	Glucose	Purity	Mfg. value	
55.05	560	19.34	15.33	0.20	79.26	13.70	3,771
34.60	520	14.98	11.31	0.68	75.50	9.85	2,385
34.15	510	15.36	12.16	0.67	79 15	10.50	2,605

Innumerable experiments by Cross (63) failed to prove the much talked-of early maturing qualities of the *P. O. J. 105*, as compared with the other canes of this series. In 1920 and 1921 most exhaustive tests were made to study this all-important point, analyses of several of the more promising canes being begun each year late in March or early in April (crop in the Argentine commences the latter part of May or early in June) and repeated each week from the same plats. The writer knows of no more complete maturity studies anywhere than those made by Cross in this series of tests. The data is very voluminous, only half of those for the year 1921 being given here, as Table IX.

TABLE IX

Ripening of the P. O. J. Canes in Tucumán

Alternate Weekly Analyses, made at the Sugar Experiment Station

P. O. J. 234, THIRD RATOONS; OTHERS, FOURTH RATOONS

P. O. J. No.	Brix	Sucrose	Glucose	Purity
		8th of April		
36	13.76	10.58	1.24	76.88
105	13.31	9.52	1.19	71.52
213	13.91	11.39	0.76	81.88
234	17.07	14.90	0.57	87.33
		22nd of April		
36	15.37	11.94	0.94	77.68
105	16.07	12.34	0.40	76.68
213	14.57	11.93	0.72	81.88
234	18.38	16.11	0.45	87.64
		6th of May		
36	15.93	12.88	0.75	80.85
105	14.43	10.87	0.67	75.32
213	16.68	14.23	0.67	85.31
234	18.38	16.22	0.29	88.24
		20th of May		
36	17.24	14.81	0.47	85.90
105	15.47	12.34	0.47	79.76
213	16.94	14 55	0.12	85.89
234	18.27	16.59	0.13	90.80
		3rd of June		
36	16.91	14.09	0.24	83.32
105	16.56	13.51	0.29	82.18
213	18.15	16.18	0.18	89.14
234	18.75	17.17	0.13	91.57

From these very complete results it may be readily appreciated that the *P. O. J. 105* is not only far from such early maturity as the *P. O. J. 234*, which is a notably early-maturing cane, but is also consistently inferior to both *P. O. J. 36* and *213*, not only in earliness of maturity, but in sugar content and purity as well.

The P. O. J. Canes in Porto Rico

It would appear that to Prof. D. W. May of the Federal Experiment Station in Mayagüez is due the credit for the introduction of most of the *P. O. J.* canes we are considering in this paper into "The Isle of Enchantment." From the Sugar Experiment Station

FIG. 8.—P. O. J. 36 in Porto Rico. A splendid field at Central "Los Caños"

in Tucumán we sent in 1915, along with the first sending of *Uba* cane, which was afterwards repeated on a hitherto unprecedented scale (57), *P. O. J. 36* and *234*, and in 1921 the Tucumán Station sent a few seeds of the *P. O. J. 213* to the Insular Experiment Station of Porto Rico. It would seem (101) that the *P. O. J. 105*

was brought from Egypt by Mr. May a number of years ago, although little attention was paid to it until after the discovery by Earle of its extreme resistance to Mosaic Disease and, like the other three *P. O. J.* canes here considered, to root diseases, although in both cases it shows more effects of disease than either the *P. O. J. 36* or *213*. Mr. Antonio Fraticelli, manager of Central "Los Caños," to whom the author is indebted for a large part of the data which he has been able to obtain on the Java canes in Porto Rico, tells us that, when he went as manager to Central "Córsica" in 1917, he found a few stools of the *P. O. J. 105* which had been practically abandoned. Struck by its good development with practically no attention being given to it in a cultural way, he began extending this cane and, as passing planters began to notice its growth and appearance, he received many requests for seed, which were generally granted. It is very probable, from what we have been able to discover, that the wide extension of this cane in Porto Rico dates from the finding of these stools by Mr. Fraticelli.

Despite the fact that there are large areas of the *P. O. J. 105* planted all over the Island, with smaller amounts in order of their naming of *P. O. J. 36*, *213* and *231*, it has been very difficult to obtain data from plantings of these canes in comparison with each other or with other standard canes. Naturally, isolated data of yields or chemical analyses without some basis of comparison with another variety under similar conditions are of very doubtful value in forming an opinion of the relative merit of any cane varieties; hence the amount of data furnished on these canes in Porto Rico may appear to be rather disappointingly small.

Mr. May has kindly furnished the following data of yields from the Mayagüez Experiment Station, the cane being 16–17½ months plant: *P. O. J. 36*, 5213 tons peracre; *105*, 42 tons; *132* 54.9. Mr. E. H. Barrow sent us the following:

TABLE X

Yields of Cane Varieties, Central Pagán, Añasco, 1924 Crop

Hacienda	Variety	Class	Tons per acre
Altagracia	P. O. J. 36	Gran Cultura	45.0
Trinidad	P. O. J. 36	1st. Ratoon	18.8
Pagán	B. H. 10 (12)	3rd. Ratoon	35.5
Pagán	P. O. J. 105	1st. Ratoon	35.0
Cipriana	P. O. J. 105	1st. Ratoon	30.0

Mr. R. L. Page, manager of cultivation for Russell & Co., wrote under date of 16th January, 1924, regarding the *P. O. J. 36* around Añasco, as follows:

"We have been farming this cane in Añasco for the past three years and find that under reasonably good conditions it gives from 40 to 50 tons as ratoons.

FIG. 9.—P. O. J. 213 at "Los Caños"

We have cut second ratoons as high as 38 tons. This cane is somewhat sweeter than the *Uba* cane and when left to reasonable maturity ranges between 13 and 16 per cent sucrose."

Mr. Fraticelli has been kind enough to furnish us the following comparative yields from "Los Caños":

TABLE XI

Comparative Production at Central "Los Caños" of Rayada and P. O. J. Canes

GRAN CULTURA

Dist. 1	Rayada	33.75 tons per acre	P. O. J. 105	50.05 tons
Dist. 2	Rayada	18.40 tons per acre	P. O. J. 36	41.85 tons
Dist. 3	Rayada	14.15 tons per acre	P. O. J. 105	49.93 tons

Mr. Fraticelli has also put at our disposition a number of comparative analyses from Centrals "Coloso" and "Los Caños." The following represents an average of three analyses each of *P. O. J. 36* and *105*, "gran cultura" from Finca Carlota near Rincón, ground in Central "Coloso" in January of this year and an average of two analyses of *P. O. J. 234* "gran cultura" of the same origin and ground in the same Central in February.

P. O. J.	Sucrose	Purity
36	16.36	85.06
105	15.06	85.28
234	16.08	85.27

The following analyses were made at "Los Caños" of "gran cultura" cane on the 23rd of January last; all from good lowlands:

Variety	Brix	Sucrose	Purity
Rayada	14.84	12.15	81.90
P. O. J. 36	17.12	14.98	87.51
P. O. J. 105	15.03	12.44	82.87

The next two analyses were made at "Los Caños" the next day:

P. O. J. 36	16.84	14.37	85.25
P. O. J. 105	15.81	12.48	78.60

Finally, through the kindness of Mr. Andrés Oliver, of Central Cambalache, the writer secured the following comparative analyses of twelve-month plant cane made in that central on the 3rd of April last:

Variety	Brix	Sucrose	Purity
P. O. J. 105	18.00	14.87	82.61
P. O. J. 213*	16.65	14.33	86.07

* Called *36* at Cambalache.

Conclusions

From the small amount of data on cultural yields and chemical analyses which we have been able to obtain under comparative Porto Rican conditions, we find that on "The Isle of Enchantment", these four *P. O. J.* canes seem to have behaved in a manner surprisingly

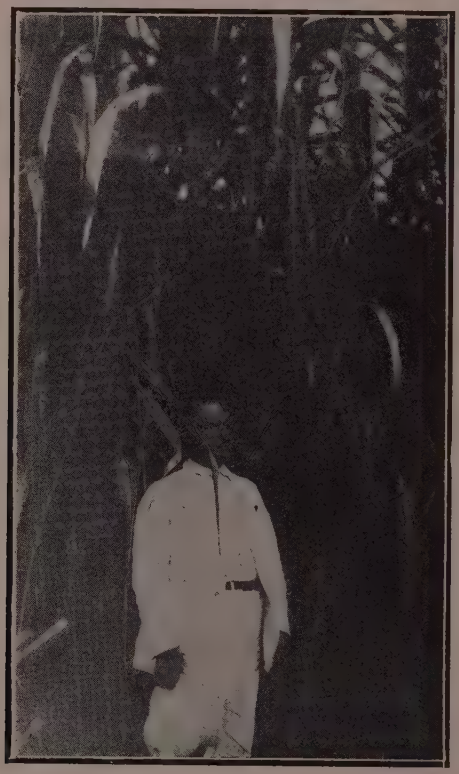

FIG. 10. — D. Antonio Fraticelli, manager of Central "Los Caños", in one of his prize fields of P. O. J. 36

similar to that displayed in Tucumán. In Tucumán we found that the *P. O. J. 36* and *213* had outdistanced all other canes in yield of cane and sucrose per acre, as well as in resistance to their 100 per cent infection with Mosaic Disease and to various root diseases. As an early maturer *P. O. J. 234* was superior to all others, but its

cultural yield was never as high, nor does it last in Argentine so many years as stubble. The *P. O. J. 105* in all Tucumán tests certainly stood at the bottom of three other sister canes in point of cultural and factory yield, long ratooning, maturity and resistance to Mosaic and other diseases. A glance at the Mayagüez results

FIG. 11.—Ratoons of P. O. J. 234 at Central "Los Caños", Arecibo. Note adventitious roots characteristic of this early-maturing variety

will show that *P. O. J. 36* and *213* have outdistanced the "Egyptian" in yield of cane per acre by over 10 and 15 tons, respectively, while the highest yield recorded in the field from Añasco is also for the *P. O. J. 36*. While actual comparative data is lacking from "Los Caños", personal inspection by the writer has shown both the *P. O.*

J. 36 and *213* to be superior to the *P. O. J. 105* in general condition in the field. The "Coloso" analyses of *P. O. J. 36*, *213* and *234* show that the *P. O. J. 105* has over a point less sugar than the other two varieties, while the "Los Caños" analyses show the *P. O. J. 36* about two points in sugar and over five points in purity ahead of the *P. O. J. 105*. Finally the Cambalache data show a superior purity of some 3½ points for *P. O. J. 213* over *P. O. J. 105*.

Why, then, is the so-called "Egyptian" cane so much more extensively cultivated in Porto Rico than any of the other three varieties, particularly the *P. O. J. 36* and *213*? The answer is hard to find except upon the grounds that the seed of the former was more easily obtainable when interests was awakened in this class of cane at the time of the outbreak of Mosaic on the West Coast and planters have learned to know this variety while seldom seeing the others herein discussed.

A Word of Warning

The writer would certainly advise Porto Rican planters cultivating the *P. O. J. 105*, or "Egyptian" cane in Mosaic Disease sections to at least try out the other three *P. O. J.* varieties discussed in this paper under the conditions of their own particular properties and in direct competition with each other, as well as with other varieties in the trial of which they might be interested. The data obtained in both Argentine and Porto Rico would certainly indicate that they are cultivating about the poorest of the prominent *P. O. J.* canes and if they verify this indication in their own fields the course to follow will be plainly seen. The cost of cultivation is about the same for these canes whether one obtains a large crop or a comparatively small one and an extra yield of ten or fifteen tons per acre so enormously reduces the ton cost of cultivation that it would seem that such trials would be well worth while.

However, the writer wishes to point out most unequivocally that HE IS NOT RECOMMENDING ANY OF THESE CANES FOR CULTIVATION WHERE AN EFFORT IS BEING MADE TO CONTROL MOSAIC, as all figures herein given for the *P. O. J.* canes are for cane *100 per cent infected with Mosaic*. While Mosaic does not seriously affect the vigor of these particular canes, their introduction into comparatively clean areas would be fatal, as they would serve as foci of infection for all surrounding fields. There are, however, considerable extensions of territory in the earlier infected sections of the

FIG. 12.—Looking down a road between two remarkable fields of P. O. J. 36 at Central "Los Caños"

Island where planters have decided to follow the same policy as was followed in Argentine in solving its Mosaic Disease problem—*i. e.*, planting only the tolerant varieties and eliminating the susceptible ones. In such districts—AND IN SUCH DISTRICTS ONLY—we can thoroughly recommended a trial of the lesser-known *P. O. J. 36*, *213* and *234* canes and if results prove that any or all of the three, under the particular conditions of the experiment, are superior to the *P. O. J. 105* already in cultivation, then it would seem the part of wisdom and common sense to gradually replace the *P. O. J. 105* with the higher yielding, sweeter, hardier and more early maturing variety or varieties indicated by such tests. We have seen that the *P. O. J. 36* and *213* have meant millions of dollars in the pockets of the Argentine planters and central owners—it is by no means impossible that they may have a similar significance for Porto Rico.

APPENDICES

A. The Fiber Content of the *P. O. J.* Canes and its Significance.
B. Descriptions of the *P. O. J.* Canes Discussed in this Paper
C. An Annotated Bibliography of *P. O. J.* Canes.

Appendix A

THE FIBER CONTENT OF THE P. O. J. CANES AND ITS SIGNIFICANCE

A frequent objection that is made to the *P. O. J.* canes is the difficulty of milling them on account of the higher fiber content, as compared with the *Rayada* or *Cristalina* type of cane. On the other hand, many persons of experience consider that the higher fiber content of these canes, instead of being a disadvantage, is a very decided point in their favor, taking into consideration the increased resistance of the higher fiber-content canes against the attacks of the common moth cane borer, *Diatraea saccharalis,* and the additional amount of *bagasse* supplied by these canes for the furnaces.

The following table gives the fiber contents of the four *P. O. J.* canes discussed here, in comparison with the *Rayada.* All but the analysis of the *P. O. J. 105* which was made by Mr. Francisco López Domínguez, Chief Chemist of the Insular Experiment Station, represent the averages of a number of fiber determinations made at the Tucumán Sugar Experiment Station.

Fiber Contents

Variety	Per cent fiber in canes
P. O. J. 36	12.80
105	13.27
213	13.00
234	12.20
Rayada	10.60
Average P. O. J.	12.82

In will be observed that all of the Java varieties run very considerably higher in fiber than the *Rayada,* averaging a 21 per cent increase.

Effect on Borer Infestation

The increased fiber content of these canes, which is particularly manifested in additional hardness of the rind and internodes, makes penetration into the inner tissues of the cane by the moth borer a very much more difficult matter than in such canes as *Rayada, Cristalina* or *Santa Cruz 12* (*4*) and, probably more important yet in its effect on the composition of the juice and in the reduction in

extraction which follows heavy borer attack, is the fact that, whereas the borer, once its tunnel is started in the softer canes, will perforate several joints, in these harder canes it has been found that, in stubble cane particularly, they seldom pass the node immediately above them and their attacks, hence, are in the majority of cases

FIG. 13—Java 36 (P. O. J.)

confined to one joint. In Tucumán we found that the average joint infestation with *Diatraea* in the native *Rayada* type of cane was 41.3 per cent over a series of years, while that for the *P. O. J.* canes *36*, *213* and *234* averaged just about 15 per cent. Barber (8) gives a large number of comparative analyses from the Audubon Park Experiment Station showing a great reduction in the manu-

facturing value of cane juices from severely attacked canes and Van Dine figured out this loss in Porto Rico at 670 pounds of sugar per acre. Using Van Dine's figures as the average for the Island, Jones (141) figured out an annual loss to the Porto Rican sugar growers at over 32,700 tons, which, calculated at but $77.50 per ton, would represent a value of over two and one-half millions of dollars. Could we cut this loss down in the same proportion as the *P. O. J.* canes are less infested with borer than the thicker, softer canes—over 60 per cent on the average—it well be seen that the acre-profit would be quite substantial.

Effect on Milling Results

Despite the many opinions to the contrary which one frequently hears expressed, there is no doubt that, with proper adjustment of the crusher rolls and the necessary changes in the feed to meet the conditions of a thinner cane with decidedly higher fiber content—which means, of course, that a layer of the P. O. J. cane of the usual depth on the conductor will contain more fiber and, hence, offer more resistance to the mills than is indicated by the comparison of the fiber contents of the *P. O. J.* canes and the *Rayada* or *Cristalina*, since the thinner canes fit more closely together and a considerably greater *weight* of cane will pass over the conductor than with the same thickness of layer of the thicker canes—very good milling results can be obtained from these canes, although their higher fiber content does undoubtedly signify a certain amount of reduction in the grinding capacity per hour of any properly adjusted milling plant and a probable small decrease in extraction under normal conditions (169).

In studying this question the writer a number of years ago, making use of the very complete Mutual Control Reports from Java, complied the comparative manufacturing figures for two sets of sugar mills in that progressive island—one lot representing the twenty-three plants which for the entire crop of 1912 ground cane with an average fiber content of above 13 per cent, corresponding to the content of the *P. O. J.* seedlings we have been discussing, and the other representing the 17 factories which that year ground cane averaging less than 11 per cent fiber, which compares quite well with our *Rayada* and *Cristalina*. The results found in the Table below are extremely interesting.

TABLE XII

Results Obtained in Java from Factories Grinding Cane of High and Low Fiber Content

Fiber in cane	No. Factories	% sucr. in cane	% sucr. extracted on 100% cane	% juice extracted on 100 parts juice	Fiber in cane	Bagasse da %		
						Sucr.	Moisture	Sucr. lost
Bellow 11.....	17	12.59	11.49	91.3	10.58	4.72	48.45	1.10
Above 13.....	23	12.25	11.06	90.3	13.61	4.29	44.99	1.1

There was little difference, then, between the results obtained by the two groups, the most important one from the calorific standpoint being that the *bagasse* from the high-fibered cane had 3½ points less humidity than that from the mills grinding canes of low-fiber content. The average per cent sucrose in cane was slightly better in the group of centrals grinding low-fiber cane and they obtained one point better extraction than the mills grinding cane of high-fiber content, losing, also, slightly less fiber in the *bagasse*.

This table seems to make further discussion of the milling of the *P. O. J.* canes unnecessary as mechanical practices, unlike agricultural ones, can be pretty well applied in any country and there is no satisfactory reason why milling results achieved with these canes in Java should not be duplicated in the very well equipped centrals of "The Isle of Enchantment".

Appendix B

TECHNICAL DESCRIPTIONS OF THE P. O. J. CANES

Very shortly after the recognition of the fertility of cane seed in 1888–89 by Harrison and Bovell in Barbados and Soltvedel in Java, working completely independently, extensive breeding of varieties was commenced by Kobus and Wakker at the Oost Java Proefstation, the Indian cane *Chunnee* (one of the *Ukh* class) being employed as the male parent and the *Black Cheribón* and *Striped Preanger* (our *Morada* and *Rayada*) as the female. This combination was used with the object of obtaining a "hybrid" with the sereh-resistant qualities of *Chunnee* and the very desirable cultural and manufacturing characteristics of the female parents, then in common cultivation in Java. All of the four canes which we have been discussing belong to this series and partake of the characteristics of the majority of the varieties produced by these crosses, *i. e.*, they all have narrow leaves, long thin joints, extremely hard rind and a modified central fistula. The following short descriptions are based on those of Jeswiet (138–9) and Fawcett (109). The colors mentioned therein refer only to the mature cane and the male parent is given first in each case in referring to the parent canes.

P. O. J. 36. Chunnee X Striped Prèanger.—Stalk light-green yellow, overlaid with rose, later with rose splashes. Numerous rind fissures visible as rose-colored stripes, no growth fissures. Wax layers distinct in younger joints, later remaining as black patches. Joints very zigzag, cylindrical concave on eye side, convex on opposite, 5 mult 1 inches. Pith dense, coarse, with small fistula. Rind very thick and hard. Growth ring very wide, horizontal, bulging slightly above eye, often with a rose-colored border. Root ring inverted cone or cylinder, 2–3 rows of roots, dark yellow, often ringed purple. No eye channel. Eyes broad, almost elliptical, compressed, upper part wide, lying close to the stalk. Germinating point nearly central, nervature almost radial. Group hairs 1, 2, 3, 4, 7, 8, 10, 12, 14, 18, 19, 21 constant; 5, 6, 11, 22, 25, variable. Leaf sheath 12 to 13 inches long, with small, inconspicuous ridge. Inner auricle always and outer sometimes present. Ligule broad, bow-shaped over eye. Leaf dark green, 3.9–4.1 cms. wide, leaf callus olive green,

with yellow margin. Group hairs 51, 52, 53, 54, 57, 58, 60, 61, 64, 66, 70, 71.

P. O. J. 105. Chunnee X Black Cheribón.—Old stalks rose-colored under wax layer, the color being diffused and disposed in indistinct fine lines over brown base. Due to the thick wax coating this color appears to be a clear grey or almost violet, the character-

FIG. 14—Java 105 (P. O. J.)

istic color of this variety. Pruinose ring notable for its entire lack of red color and for its slight construction. Joints somewhat zig-zag, long, the younger ones cylindrical; in the older ones the eye side is straight and the opposite side slightly convex, the lower joints being somewhat inversely conical. Pith dense, with thick fibers. Rind hard, but not so thick as in the *P. O. J. 36*. Growth ring with fundamental color of joints, sometimes slightly constricted,

but never swollen. Root ring somewhat narrower at the top in the upper joints and convex and swollen in the lower ones; rudimentary roots almost same color as the base on which they appear, this being of a dark red color in the middle joints. The color of this zone is at times rather rosy and becomes darker upon exposure to light; also covered with wax; rudimentary roots tenuous and persistent. Well developed eyes broad, elliptical and compact, upper part widely alate and slightly pointed, the angle of the germinating point obtuse and the edges of the "wings" slightly dentate. The eyes just exposed to the sun are purplish toward the germinating point, which is found at the upper center of the eye. At first the buds are flattened, later becoming convex. The interior edge of the "wing" has some small hairs (4), with groups in the exterior angles (26). The "wing" itself is covered with short, fine, black or white hairs (12), while the basal belt (1 and 2) of white hairs is always present, although the hairs are relatively sparse. Nervature free of pubescence. In the exterior angles of the "wing" covered with short black hairs (21), these also being found on the upper part of the eye (23), where they are mixed with long white hairs (10). At the base are found at times external groups, (19) which combine with group 18. Groups 1, 2, 16, 4 of the external side and 18 and 19 of the internal are almost always present, the others at times being lacking. Leaf sheath dark green, pruinose and smooth except at base, where there are occasionally found some short hairs (58). Leaf scars oblique. Inner auricle lacking, exterior small (5 mm. in length) or lacking. Ligule narrow. Ring yellowish or greenish, with fine white or black hairs, which unite with the groups which are found on the nervature and which are not numbered. Leaf dark green, long and narrow, basal leaf callus green and covered with fine white pubescence (52). The hairs are longer along the edge (51) on the upper side. The lower side, besides being pubescent (58), is somewhat pruinose.

P. O. J. 213. Chunnee X Black Cheribón.—Stalk dark purple to brown red. Rind fissures in older joints, no growth fissures. Wax layer at first plain and thick, diminishing with age, wax ring sharply defined. Joints slightly zigzag, cylindrical, slightly concave on eye side, convex on opposite, 6 to 9 by three-fourths to one inch. Pith smooth, often with a fistula, rind hard. Growth ring horizontal, wide, smooth, yellow splashed with red. Root ring cylindrical, more or less concave, broader than stalk, dark brown,

2 rows of roots. Eye channel almost always absent, distinguishable in older cane as a flattening. Eye elongated egg-shaped, triangular point, broad wing, very flat, germinating point apical, nervature converging to top. Hair groups 1, 2, 12, 19, 21, and 26 constant, 10 and 11 variable. Leaf sheath 11 inches long with fissures one-half inch long. Auricle almost always absent, small and stumpy.

FIG. 15.—Java 213 (P. O. J.)
Central Cambalache

Ligule very wide and smooth. Leaf 1½ inch wide, callus yellow-green, waxy. Hair groups 51, 52, 53, 54, 57, 60, 61 and 62.

P. O. J. 234.—Lowler joints green tinged with purple, upper yellow-green with thin brown striping, wax layer thick. Rind thinner than in other canes above described. Growth ring bronze where exposed and pale green or yellow in upper joints. Two or

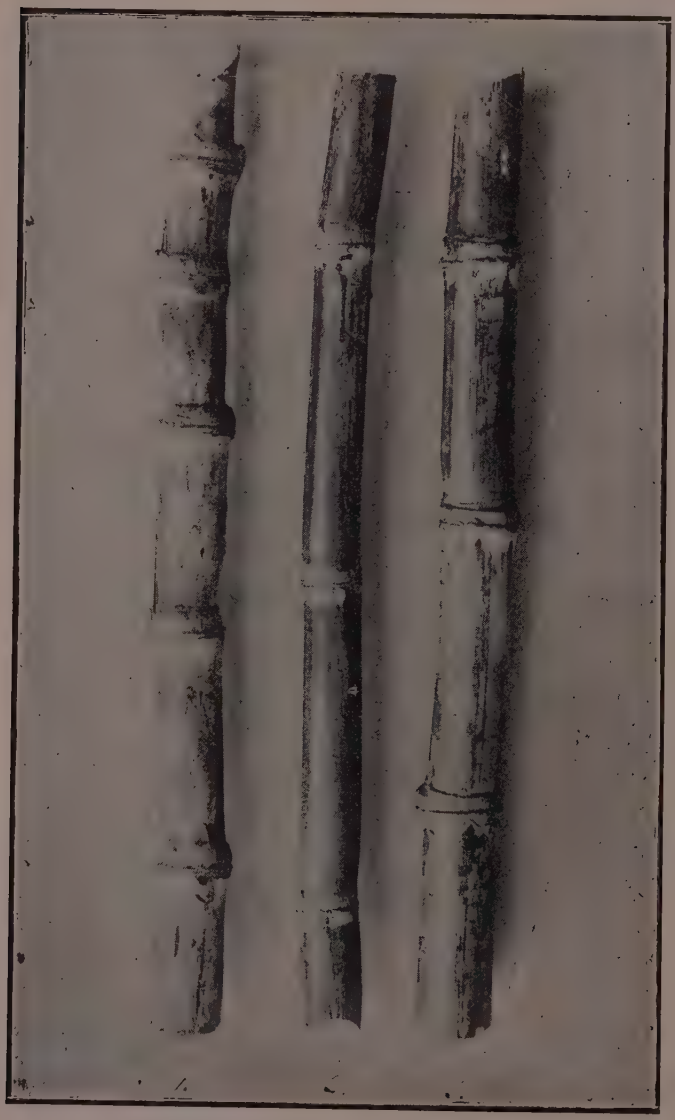

FIG. 16.—1. Java 106 (P. O. J.); 2. Java 213 (P. O. J.); 3. Java 36 (P. O. J.)

three rows of roots. Wax ring narrow and in lower joints thickly covered with wax. Eye channel conspicous in middle joints. Eye narrow, semicircular below, upper part making an angle of a little less than 90 degrees. Germinating point almost apical, nerves fine and numerous. Hair groups 1, 3, 12, 21, 23, and 26 constant, 2, 10, 16, 18 and 19 variable. Inner auricle when present is 1–2 mms. long. Outer auricle 5–10 mms. long, always present. Leaf long, narrow, dark green, callus pale yellowish green.

Appendix C

AN ANNOTATED BIBLIOGRAPHY OF THE P. O J. CANES

Abbreviations.—Three journals which are repeatedly quoted in this list are abbreviated therein as follows:

Revista Industrial y Agrícola de Tucumán (Argentina)—*Rev. Tuc.*
Mededeelingen van het Proefstation voor de Java-suikerindustrie—*Med.*
International Sugar Journal of London—*I. S. J.*

Agee, H. P.

(1) The Propagation of New Cane Varieties from Seed. La. Planter; April, 1911. Mentions, in a detailed review of varietal work at the Audubon Park Expt. Sta., importation of *POJ 234* into Louisiana from Tucumán, (Argentina) Sugar Exp. Sta., but lack of later mention in La. Repts. would indicate that it was never extensively tried out there.

(2) Resistance to Disease and Adverse Agricultural Conditions by Hardy Sugar Cane Types. Rept. of Committee in Charge of Expt. Sta. to Hawaiian Sugar Planters' Assn., Sept. 7, 1923. Recent collapse of standard sugar-cane varieties in Porto Rico through attacks of Mosaic and root diseases have brought this subject into much prominence. Earle's list of var. more or less immune to root diseases, in which he singles out *POJ 36, 105* and *234* as immune, is referred to. Reference is also made to the rehabilitation of the Argentine sugar industry by the introduction and extension of *POJ 36* and *213* and to the introduction of *POJ 36* into Formosa & *J. 105* into Egypt with striking results.

(3) Resistant Cane Varieties. Rept. to Haw. Sug. Plant. Assn., 24. Mentions introduction into Hawaii from Java of apparently clean seed of *POJ 36, 213* & *234*, inspired by striking results from these canes in Argentina, Porto Rico & Formosa.

Andino, A. M. de, y Colón, Eduardo

(4) Cane Varieties in Northern Porto Rico. Mem. of the Assn. of Sug. Technologists of P. R., I, 1; pp. 1–4; 17th June, 1922. An interesting little review of results with some canes at Central Plazuela.

Arango, Rodolfo

(5) La Enfermedad de las "Rayas Amarillas" o "Mosaico" en la Caña de Azúcar. La Hacienda, pp. 106–9, Ene., 1921. Quotes some figures, probably erroneously, from Rev. Tuc. on yields of *Uba* compared with *POJ* canes.

Avila, Julio P.

(6) La Caña Azúcar en las Indias Occidentales. Tucumán, Argta.; 1923; pp. 1–98. Historical.

Barber, C. A.

(7) Cane-Breeding in Hawaii. I. S. J., XXVI, pp. 245–9; May, 1924. Review of recent work in Hawaii. "Cane varieties and seedlings raised in Mauritius, Barbados, Java, Demerara and other countries, have been spread all over the world and have in many cases given a fresh impetus to the sugar industry but we nowhere meet with forms of such wide distribution as the old *Bourbon,* which presumably was not a seedling."

Barber, T. C.

(8) Damage to Sugar Cane in Louisiana by the Sugar-Cane Borer. U. S. Bur. Entomology, Circ. 139, p. 12; 1911. Gives numerous analyses of infested and borer-free cane at Audubon Park Experiment Sta. and shows in every case heavy deterioration to manufacturing value of juices due to borer attack and inversion and disease following thereafter.

(9) Trabajos Proyectados con Insectos de la Caña. Rev. Tuc., III, pp. 95–102; agosto, 1912. "In the main and substations a number of foreign varieties of sugar cane are now being tried out . . . . These will be carefully observed . . . with the object of determining if the damage caused by insects varies with distinct varieties and different climatic conditions."

(10) Trabajo de las Subestaciones para 1912–13. Rev. Tuc., III, pp. 142–5; Sept., 1912. Outlines varietal expts. in substations.

Bennett, A. G.

(11) Informe de Subestaciones para el Año 1914. Rev. Tuc., V, pp. 202–19; Oct., 1914. In Monte Bello *POJ 36* yielded 35 tons cane per hect., *213* gave 55½ and *234* yielded 23½ tons in comparison with 15 tons for the *Rayada.* In San Pablo the yields per hectare were, for the *POJ 36,* 59 tons, and for the *213,* 65½ tons, in comparison with the very good yield of 39 tons for the *Rayada.* In this expt. *POJ 234* lead all other varieties (14 in number) in sugar content of juice —19.42%—the *Rayada* showing 16.37%. *POJ 105* yielded 50 tons cane per hect., with 16.37% sucrose in juice and a purity of 81. In Aguilares *POJ 36* lead the 7 varieties tried with 90 tons cane and 7 tons sugar per hect. In Luján *POJ 213* lead with 83 tons cane and 6½ tons sugar, an exceptional yield for that dry section.

BLOUIN, R. E.

(12) Variedades de Caña. Rev. Tuc., II, pp. 73–115; 1911. Gives results from first crop of *POJ* and some 200 other varieties harvested in the Tucumán Sugar Expt. Sta. Lists *POJ 36, 213* and *234* amongst the 20 varieties so far giving superior results to those obtained with the staple cane of the country, the *Rayada.*

(13) Estudio de Nuevas Cañas. Rev. Tuc., II, pp. 214–7; 1911. Letter to Mr. Carlos R. Hamakers, who had offered to secure large quantities of the *POJ* canes for *Tucumán* on a visit to Java, advising against any such wholesale and expensive importation on the basis of such short experience in the Tucumán Sugar Expt. Sta. with these canes.

(14) Informe sobre los Trabajos Efectuados en la Estación Agrícola durante 1912–1913. Rev. Tuc., III, pp. 417–506; 1913. Includes *verbatim ad literatim* Rosenfeld's "Diez de las Cañas Más Prometedoras" (166) and Barber's "Trabajo de las Subestaciones" (10).

(15) Una Comparación de los Resultados de los Ensayos con las Cañas de Java con los de las Cañas "Kavangire", "Zwinga" y Morada y Rayada del País. Rev. Tuc., IV., pp. 141–50; Sept., 1913. Interesting comparison of three years results with these varieties. Classifying results as second ratoons, *POJ 213* and *234* stood at head of list as regards percentage sucrose in juice, *Zwinga* and *Kavangire* (*Uba*) lead *POJ 213* and *36* in yield of cane per acre and *Zwinga* surpassed *POJ 213* in total sugar produced per acre. In fiber content *Uba* lead all varieties with 13.1% and also showed most rapid inversion after cutting — dropped from 83.4% purity to 25.4% in 12 days.

(16) Variedades de Caña. Rev. Tuc., IV, pp. 192–200; Oct., 1913. Gives results of crop of second ratoons, as well as first ratoons, of *POJ* and some 200 other cane varieties. *POJ 213, 36* and *234* stood out prominently in order given.

BLOUIN, R. E., & ROSENFELD, ARTHUR H.

(17) Memoria sobre los Trabajos y Progresos de la Estación Exptl. Rev. Tuc., I, 11, pp. 1–47; Abr., 1911. "Some of these varieties give considerable promise, especially some of the Java seedlings."

(18) *Idem.* II, pp. 423–85; 1912. Contains short discussion of work with varieties for two years.

(19) Informe sobre los Trabajos Efectuados en la Estación Exptl. Agrícola durante 1913–14. Rev. Tuc., IV, pp. 369–481, 1914. Very complete report on Sta. work to date, including list of all articles on varieties published in Rev. Tuc. from the first no. in June, 1910. These

are 10 in number, by Blouin, Zerban, Rosenfeld and Hall. *POJ 36, 213* & *234* show up strikingly well in this rept. in the central station as well as in the substations.

BRANDES, E. W.

(20) The Mosaic Disease of Sugar Cane and Other Grasses. U. S. D. A. Bull. 829, pp. 1–26; Oct., 1919. Discusses resistance of Java varieties. Mentions *POJ 36* as *56*.

CALVINO, EVA MAMELI DE

(21) Estudios Anatómicos y Fisiológicos sobre la Caña de Azúcar en Cuba. Estn. Exptl. Agronómica de Cuba, Bol. 46, p. 5; Abr., 1912. "The Java cane industry subsists only as a result of the new seedlings obtained and selected by its experiment stations. The same is the case in the British West Indies, in Demerara, in Argentine Republic, etc."

CROSS, W. E.

(22) El Contenido de Fibra y el Problema de Combustibles. Rev. Tuc., V, pp. 197–8; Oct., 1914. In a most interesting little note gives fiber content in Tucumán of various *POJ* and other canes and concludes that high fiber content of the former will help to reduce wood consumption in the furnaces of the centrals. "The new varieties which have given the most promise in the Experiment Station as regards tonnage and sugar content have comparatively high fiber contents, being equal in this respect to the very best varieties which are today being widely cultivated in Java and Hawaii."

(23) Algunos Resultados de la Introducción de Variedades Extranjeras. Rev. Tuc., V, pp. 271–3; Nov., 1914. Short review of work of producing and introducing new sugar-canes varieties in various countries, particularly of the work of Kobus, the producer of the *POJ* canes, and the extension of these varieties to other countries.

(24) La Cosecha de las Nuevas Variedades de Caña. Estación Exptl. Agr. de Tucumán (Argentina), Circ. 2, p. 2; Feb. 1916. Calls attention to rapid inversion of *POJ* canes after cutting and advises their very prompt delivery to factory.

(25) Memoria de la Estn. Exptl. Agrícola correspondiente al Año 1915. Rev. Tuc., VI, pp. 463–89; Abr., 1916. Rept. as Acting Dir. in absence of Director Rosenfeld. In regard to varieties says, "A complete rept. on this work was compiled by the Director, Mr. A. H. Rosenfeld, and published in a special no. of the *Revista* . . . As a result of five years of study of the Java canes the conclusion was reached that the *POJ 36* is the best

variety from every standpoint and the cane destined to replace the native (*Rayada*) in the province. The next cane recommended was the *POJ 213*, third choice going to the *POJ 234.*"

(26) Un Progreso Epocal en Tucumán. Rev. Tuc., VI, pp. 502–5; Abr., 1916. Considers that successful work of Tucumán Sugar Expt. Sta. with varieties, especially the results from and rapid extension of *POJ 36* and *213*, places Tucumán, in spite of its rather unfavorable climate and subtropical conditions, in a position where its yields of cane and sugar per acre can compare favorably with the averages in countries much more favorably located for cane growing.

(27) Renuncia del Sñor. Arturo H. Rosenfeld. Rev. Tuc., VII, pp. 91–4; Agst., 1916. "The Station's field experiments were under the direct personal charge of Mr. Rosenfeld for many years and he is responsible for the prolific experimentation with the Java seedling canes, which were carefully and exactly studied from every angle before being definitely recommended to the planters of the province . . . It was logical that, as he was the person who had had the most experience with these Java canes and who best understood the most effective and cheapest methods of planting and cultivating them, he should be the technologist called to scientifically direct the large-scale renovation with these seedlings."

(28) El Empleo del Despunte para Plantar. Rev. Tuc., VII, pp. 134–8; Sept., 1916. Gives results of two series of expts. made by Rosenfeld and records starting of a new series along the same liñe with *POJ* canes.

(29) Repartición de Cañas de Java y Caña Forrajera. Rev. Tuc., VII, pp. 153–9; Sept., 1916. "The remarkable results from the Java canes which have been under the study of this institution for seven years and have been strongly and definitely recommended by the Station . . . . have had as a result the planting on a truly enormous scale of said varieties all over the province."

(30) Programa de las Experiencias Agrícolas a Realizarse desde Agosto, 1916, hasta Agosto, 1917. Rev. Tuc., VII, pp. 265-72; Dic., 1916. Well-laid-out plan of agricultural work for year, with plan of experimental fields including "the careful study of the Java and forage canes as regards their characters of growth and resistance to drought and disease."

(31) Noticias de la Estación. Rev. Tuc., VII, pp. 292–3; Dic., 1916. Reports that Station is continuing importation of promising varieties of cane from all parts of the world. It is thought that results even more successful than those obtained with the Java canes should result

from the continual trying out of new varieties in carefully planned experiments."

(32) Variedades de Caña en la Estación Experimental. Rev. Tuc., VII, pp. 311–25; Ene., 1917. "In the November, 1915, edition of the Rev. Tuc. (III–6) Mr. A. H. Rosenfeld published a detailed study of the results obtained during five years of experimentation with foreign varieties of sugar cane. The object of this publication is to bring up to date the data published on that occasion by Mr. Rosenfeld by adding the figures obtained from the crop of 1916."

(33) Memoria de la Estación Experimental Agrícola correspondiente al Año 1916. Rev. Tuc., VII, pp. 357–89; Feb., 1917. "*Las Cañas de Java.*—The success of the experimental work realized at the Station with these canes and the results of five years of careful study impelled us to definitely recommend them in November, 1915. As is well know, they are now replacing the creole canes in a manner almost without precedent in the history of the world's sugar industry . . . . The Experiment Station can now guarantee the success of the new varieties and of the industry depending upon them."

(34) Algunas notas sobre la Plantación de la Caña de Java. Rev. Tuc., VII, pp. 390–3; Feb., 1917. Cane for planting purposes should be as fresh as possible, particularly seed of *POJ 36, 213* and *234,* which deteriorate very rapidly not only from manufacturing standpoint but "in germinating power, after cutting. Irrigation should be given immediately after planting where possible, above all if cane is somewhat dry when planted, and the cane planted deep after good soil preparation. Cane should also be covered as soon as possible after planting. In case of being forced to plant somewhat dry cane it would be highly advisable to increase amount of seed employed per acre.

(35) La Selección de Caña de Azúcar en la Cosecha. Rev. Tuc., pp. 394–8; Feb., 1917. With advent of *POJ* canes in Tucumán province new factors are introduced into cropping routine and author recommends system of sampling cane fields to determine maturity before harvesting each one, these analyses to commence several weeks before crop. "The advantages of such a system of study of cane maturity are many. It places the crop upon a perfectly rational basis, avoids the harvesting of distinctly unripe cane and assures the grinding at he proper time of the most mature fields."

(36) La Inspección de Plantas Importadas. Rev. Tuc., VII, pp. 405–16; Mar., 1917. Letter from Director of the Tucumán Expt. Sta. to the President of the Board of

same calling attention to necessity of a plant-quarantine law for the province. Discusses the replacement of *Rayada* cane by the *POJ* varieties and states that some carelessly imported disease or insect might possibly lead to a decline in the value of the latter canes. Lists dangerous diseases and insects susceptible of easy introduction. In compliance with this indication Governor Padilla decreed a plant-quarantine law on the 30th of March, 1917.

(37) Ensayos Cooperativos. Rev Tuc., VII, pp. 435–42; Mar., 1917. Outlines a series of ten proposed coöperative expts., for the basis of which, in the case of sugar cane expts., the *POJ 36* and *213* are mainly recommended. Expts. include liming, trash burning, early cutting, use of stubble shaver, varieties, fertilization, amt. seed most advisable for use, spacing and rotation of crops.

(38) Plantación de Caña. Rev. Tuc., VII, pp. 446–7; Mar., 1917. Expts. with Java canes indicate that they should be pltd. as soon as possible after cutting, in furrows recently opened, irrigating, where possible, shortly after pltg. No advantage to be gained by stripping the seed before pltg.

(39) Lista de las Variedades de Caña que se Han Ensayado en la Estación Experimental Agrícola. Rev. Tuc., VII, pp. 451–69; 1917. As inquiries are frequently received as to whether this or that variety has ever been tried at Expt. Sta. it has seemed advisable to publish in one article a complete list of all varieties tried at Sta., with brief observations as to results obtained with each. Discusses *POJ 36, 213* & *234* under one heading, observing: "These canes have now come to be the basis of the Tucumán sugar industry, the Creole canes having notably degenerated."

(40) Noticias de la Estación. Rev. Tuc., VIII, pp. 30–3; 1917. Mentions efforts being made by the Tucumán Sta. to obtain flowers of the *POJ* canes under the more tropical conditions of the northern provinces of the Argentine in order to breed Tucumán seedlings from same.

(41) Pp. 78–80; 1917. Describes irrigation expts. with *POJ* canes at Tucumán Sugar Expt. Sta., employing standards worked out in Hawaii as to quantity of water required.

(42) Cañas Prometedoras en la Estación Experimental. Rev. Tuc., VIII, pp. 101–6; 1917. Results from some of the more recently imported canes, as well as from a number of those under trial for several years. Amongst the former figure *POJ 105* (discussed as *Egyptian*

Amber), *L 511, BH 10/12, Yon Tan San* (possibly our *Java Unknown*) & *D 1135*.

(43) Resultados de Caña Soca del Quinto Año en la Estn. Experimental. Rev. Tuc., VIII, pp. 106–7; 1917. Interesting figures from original plntg. of the *POJ* canes at the Tucumán Sta. As fifth ratoons *POJ 213* yielded 87 tons of cane and almost 10 tons sugar per hect. *POJ 234* gave 47½ tons cane and nearly 5 tons sugar and *POJ 36* showed yields of 45 tons cane and 4 tons sugar.

(44) Tratamiento de la Caña Dañada por las Heladas. Est. Expt. Ag. de Tucumán (Argentina), Circ. 7; July, 1918. Discussion of effect of different degrees of cold on standing cane, particularly on the *POJ* varieties, considering, also, methods of avoiding or reducing frost damage and the handling of deteriorated canes at the factory.

(45) Tratamiento de la Caña Helada—Notas Adicionales I & II. Rev. Tuc., VIII, pp. 270–7; 1918. Further considerations on this subject, particularly as regards procedure in factory, advisability of alcohol distillation of deteriorated juices, use of frozen cane as forage, etc.

(46) La Caña Java 228. Rev. Tuc., VII, pp. 279–82; 1918. After Fawcett's definite decision that the two *POJ* canes cultivated in Tucumán as *139* & *228* were both *POJ 228*, the *POJ 139* having proven a very inferior variety in trials at the Expt. Sta., author publishes results of Rosenfeld's previous expts. with the *POJ 228* in comparison with *36*, *213* & *234*. "It has proven to be an excellent variety which gives good yields of cane and sugar per hectare. It is somewhat late in maturing."

(47) Estudios Relacionados con la Experimentación con la Caña de Azúcar. Universidad de Tucumán, Depto. de Investigaciones Agrícolas, No. 5, pp. 1–109; 1918. A series of six lectures given agricultural students. "After five years of variety work the recommendations of the Station have been limited to four varieties which appear advisable for the manufacture of sugar (*POJ 36, 213, 228 & 234*)."

(48) Informe Anual del Año 1917. Rev. Tuc., IX–1, pp. 1–31; 1918. "The replacement of the Creole cane by the Java seedlings, definitely recommended by the Experiment Station in 1915, can now be said to have been concluded. In fact the crop of 1918 will consist largely (more than 90%) of Java canes."

(49) Ensayos sobre Plantación de Cañas Java y Criolla. Rev. Tuc., IX, pp. 48–50; 1918. Results of two very interesting experiments to test effects on *POJ 36* and

on *Rayada* of plantg. seed immediately after cutting and of leaving it for up to 9 days before planting (in Tucumán this system of *amortiguar* seed was once very common). The *POJ 36* from old seed gave less than half the cane and sugar per acre produced by the fresh seed, whereas the *Rayada* results showed no detrimental effects from allowing the seed to dry out for the maximum.

(50) Ensayos sobre Métodos de Impedir la Descomposición de la Caña Helada. Rev. Tuc., IX, pp. 51–6; 1918. Windrowing experiments under Tuc. conditions turned out quite contrary to results obtained in Louisiana practice, the windrowed cane inverting more rapidly in Tucumán than frozen cane left standing. *POJ 36, 213* & *234* used in these expts.

(51) Ensayos con Abonos para la Caña de Azúcar. Rev. Tuc., IX, pp. 72–85; 1918. Reviews Rosenfeld's extensive series of fertilizer investigations with native canes (*Rayada*) and brings up results to date. Gives results of new series started with *POJ 36* & *213*, in which potash and phosphoric acid again failed to show any appreciable effect on yield or analyses, while the increased yield from the use of nitrogenous fertilizers would hardly pay cost of these and application of same. Results from liming also proved negative.

(52) El Problema de la Caña Helada. Rev. Tuc., IX, pp. 102–9; 1918. During crop of 1918 Tucumán suffered most severe frosts of her history, the *Rayada* showing much more severe effects than did the *POJ 36*, *213* & *234*, which proved notably resistant—"Much more resistant than one could have expected from any cane. This resistance is of the greatest value for the Province."

(53) Experimentos sobre el Deshoje de la Caña. Rev. Tuc., IX, pp. 110–14; 1918. Reviews work done along line of disproving any value from stripping standing cane in Hawaii and Porto Rico and gives results of an exhaustive series of stripping tests in the Tuc. Agr. Expt. Sta. with *POJ 36, 213, 228* and *234*, which also failed to show any gain in tonnage from this very expensive process.

(54) "Las Cañas de Java" en Java. Rev. Tuc., IX, pp. 152–8; 1919. Study of culture of *POJ 36, 213, 228* and *234* in Java, with tables showing acreage of each of these varieties cultivated on the various Java plantations. In very few centrals are any of these canes pltd. on a very large scale, *POJ 36* & *213* occupying a maximum of 10% each of the cane area of 8 plantations and only one plantation cultivating *POJ 234* (about 20 acres all told).

(55) Las Cañas Tucumanas en la Cosecha de 1919. Rev Tuc., IX, pp. 161–7; 1919. First published results from Tucumán seedling canes. "All these thirty are less fibrous than the Java canes now cultivated in the Province. They are also thicker than the latter."

(56) Los Ensayos con Abonos para la Caña de Azúcar. Rev. Tuc., IX, pp. 170–8; 1919. Fertilizer expts. and results with *POJ 36* and *213* in both limed and unlimed soils. Stable manure gave no positive results, nor did sulphate of ammonia show any consistent gains, but both varieties responded readily to green fertilization and crop rotn.

(57) Importante Exportación de Caña de Azúcar. Rev. Tuc., IX, pp. 178–82; 1919. Mentions sending of *POJ 36, 213, 228* & *234* and *Uba* from Tuc. Agr. Expt. Sta. to Porto Rico in 1915 and later sending of 10 tons *Uba.*

(58) La Desfibradora "Searby". Rev. Tuc. IX, pp. 182–4; 1919. Correspondence with Prof. H. P. Agee, Director of the Sugar Planters' Expt. Sta. in Hawaii, *et al.* in regard to probable usefulness of a shredder on the lines of the "Searby", so much used in Hawaii, for easier handling at the mills of high-fiber content canes like *POJ 36.*

(59) "Las Cañas de Java" en Java—Una Corrección. Rev. Tuc., IX, p. 184; 1919. Correcting column "Ks. Cane per Hect." erroneously published in original article (54).

(60) El Deterioro de las Cañas Cortadas. Estn. Exptl. Agric. de Tuc., Circ. 7, pp. 1–3; 1919. "It is a well known fact that the Java canes commonly cultivated in the Prov. undergo a very notable deterioration after being cut if they are not very promptly ground."

(61) Informe Anual del Año 1918. Rev. Tuc., X, pp. 1–30; 1919. "The Java canes are employed as the basis of the field work of the Station (especially the *POJ 36* & *213*), having been long since definitely recommended by the Station and being now the basic canes of the provincial sugar indsty."

(62) El Problema de la Caña no Molida. Rev. Tuc., X, pp. 42–5; 1919. Discusses expts. made by Hall and Rosenfeld in leaving *POJ 36, 213* & *234* without harvesting for two yrs. with good results and no deterioration and gives favorable results of further expts. along this line. "The stools of the *caña dejada* had not suffered any damage whatsoever despite the length of time it stood before crop."

(63) Recientes Resultados con Algunas Variedades de Caña. Rev. Tuc., X, pp. 74–9; 1919. "A variety which has attracted considerable attention in the Province is the *POJ 105,* first introduced under the name of 'Egyp-

tian Amber.' Results obtained and observations carried out indicate that this cane, although quite a promising variety, cannot in any way compare with the *POJ 36* and *213*. Generally it gives smaller agricultural yields than the latter, it is more susceptible to disease and is not of such early maturity as was at first thought."

(64) Distancia a que Debe Plantarse la Caña de Azúcar. Rev. Tuc., X, pp. 87–100; 1919. "The practical conclusion arrived at from these results, is, therefore, that *POJ 36* & *213* should be planted with the minimum distance between the rows that will permit of implement cultivation. We have found that a distance of 6 ft. allows of easy cultivation with machinery."

(65) La Necesidad de la Rotación de Cultivos. Rev. Tuc., X, pp. 115–24; 1919–20. "The Java canes, even more than the Creole ones, should be rotated, since they produce twice the tonnage given by the indigenous varieties."

(66) El Tratamiento de la Caña Dañada por las Heladas. Rev. Tuc., X, pp. 143–53; 1920. Finds that *POJ 36, 213* & *234* are much more resistant to the effects of frost than *105*.

(67) La Caña Java en Tucumán. Revista Azucarera de Buenos Aires, XVIII, pp. 207–9; July, 1920. Interesting study of Tucumán's 1919 crop, devoted largely to the substitution of the *Rayada* cane with the *POJ 36* & *213*.

(68) Rotación de Cultivos para la Caña de Azúcar. Una Parte Esencial de la Agricultura de la Caña de Java. "Sugar", N. Y., XXII, pp. 683–6; Sept. 1920. "The author desires in this article to call attention to the absolute necessity of adopting, as one of the necessary modifications in cultural methods brought about by the use of the Java canes, the system of crop rotation. Also he may be allowed to state that the Tucumán planters should not object to adopting some such system of agriculture, since the agriculturists of the remotest ages have always recognized such a system as necessary and inevitable."

(69) Informe Anual del Año 1919. Rev. Tuc., XI, pp. 1–44; 1920. "The past year has been the most notable in the history of the Station, since in that period we have seen the absolute justification of the recommendations made by the Station in 1915 (at that time directed by Mr. Rosenfeld) in regard to the substitution of the Creole cane by certain Java varieties. These recommendations have now been carried out all over de Province. The splendid results obtained in

1919 in all parts of the Province constitute the most eloquent justification of our recommendations."

(70) Estudio de la Caña Dejada. Rev. Tuc., XI, pp. 85–99; 1920–*21*. Analyses and studies of *POJ 36, 213* & *234* left for two years before harvesting. "It cannot in any manner be said that chemically or technically the *caña dejada* was not apt for sugar manufacture. On the contrary, it showed high purity, low glucose and good adaptability for the factory."

(71) Un Ejemplo de la Resistencia de las Cañas de Java a las Heladas. Rev. Tuc., XI, pp. 103–5; 1920–21. Demonstration of the remarkable resistance of these canes to frost.

(72) Distancia a que se Debe Plantar la Caña de Azúcar. Rev. Tuc., XI, pp. 118–21; 1921. Expts. with *POJ 36* & *213*. "The selection of the best distance between the rows, therefore, must depend upon the factor of economy; the distance should be selected which gives the cheapest production of cane per ton."

(73) Las Posibilidades de las "Cañas de Java" en Luisiana. Rev. Tuc., XI, pp. 118–21; 1921. Recommends the introduction of these canes into Louisiana and their study under the conditions of that State which are so similar in general to those of Tucumán.

(74) The Java P. O. J. Canes. La. Planter, LXVI, p. 202; 1921. Address before the La. Sugar Planters' Assn. in New Orleans, advising trial of these canes. "We venture to predict success from the use of the Java canes in La."

(75) Ensayos sobre Métodos de Plantar la Caña—I. Rev. Tuc., XII, pp. 65–70; 1921. Gives yields of *POJ 36* planted *en chorro* and according to Reynoso system.

(76) Estudios con Variedades de Cañas Importadas. Rev. Tuc., XII, pp. 72–92; 1921. Interesting data on *POJ 105* and short bibliography of previous publications in Rev. Tuc. on varieties. Also data on *BH 10(12)* and *D 1135*. "The *POJ 105* proves to have some very good characters, but is clearly inferior to *POJ 36* & *213*. We have not been able to confirm its supposed early ripening, of which much was said a few years ago."

(77) Ensayos sobre Métodos de Plantar la Caña—II. Rev. Tuc., XII, pp. 93–8; 1922. Continuation of (75).

(78) Ensayos de Cultivo de Caña con Caupi en las Trochas. Rev. Tuc., pp. 99–102; 1922. Cowpeas in middles had no effect.

(79) Ensayos sobre el Cultivo de la Caña sin Quemar la Maloja. Rev. Tuc., XII, pp. 103–10; 1922. Expts. with *POJ 213*. "The most correct conclusion, as is indi-

cated by the average results from the two expts., is that the cane which did not have the trash burned gave the same yield of cane and sugar per hectare as that of which the trash was burned."

(80) La Estación Experimental Agrícola de Tucumán—Su Contribución a la Industria Azucarera de Puerto Rico. Rev. Tuc., XIII, pp. 207–11; 1923. Gives history of sending of *Uba* & *POJ 36* from Tucumán Sug. Expt. Sta. to Mayagüez Sta. in 1915 and discusses excellent results obtained.

(81) La Caña del Lote Fundador de la Estación Experimental. Rev. Tuc., XIII, pp. 211–14; 1923. Gives results through 12th-yr. stubble of original plantation of *POJ* canes at Expt. Sta. "The varieties *POJ 36* & *213* . . . maintained their high yields even in the last years . . . These results demonstrate the long duration of these varieties, *i. e.*, that they can be cropped commercially through many years of ratoons."

(82) Observaciones sobre la Situación de la Industria Azucarera en Louisiana. Rev. Tuc., XIV, pp. 8–13; 1923. Compares present situation of Louisiana cane industry with situation existing 15 yrs. ago in Tucumán, before the establishment of the Tucumán Sugar Expt. Sta. and the introduction of the *POJ* canes. Disagrees with the Rept. of the Comm. on Agr. Progress to the effect that recent poor crops in La. are due to soil exhaustion and thinks that, just as in Tucumán with the Java canes, larger yields were obtained than ever before. Lousiana ought to work in the same direction by fighting Mosaic Disease and working with resistant or immune varieties.

(83) Experimentos con la Caña Criolla. Rev. Tuc., XIV, pp. 16–19; 1923. Discusses replacement of Creole (*Rayada*) cane in Argentine by *POJ 36* & *213* and expts. once more initiated in 1917 to determine if, by abundant fertilization and best cultivation, selected *Rayada* could be made to compete advantageously with the *POJ* varieties. The expt., as in previous cases, turned out negatively.

(84) El Procedimiento de Quemar la Caña en Cosecha. Rev. Tuc., XIV, pp. 29–36; 1923. Discusses expts. to determine the possibility of substituting burning for usual stripping of varieties with closely adhering leaf-sheaths like *Uba* or *POJ 213*.

(85) Informe sobre Cañas "Tucumanas" de Semillero. Rev. Tuc., XIV, pp. 37–49; 1923. "Some of the varieties may prove tolerant to Mosaic, in the same manner as are the *POJ 36* & *213*.

Cross, W. E., and Belile, J. A.

(86) La Deterioración de Cañas Cortadas. Rev. Tuc., V, pp. 277–90; Dic., 1914. An exceptionally profound and completely original study of this problem. Commenced by Hall and brought to successful conclusion by authors. Cane-juice inversion has been attributed to a number of causes by distinct technologists, but this is perhaps the first time that the theory of enzymic inversion has been advanced in this connection—and apparently proven. The question of control of inversion has been carefully investigated by the authors and important experimental data, the basis of much future investigation, was obtained. Authors consider that same enzymic action that is responsible for rapid inversion of *Uba* and *POJ* canes is probably cause of rapid and prolific germination of these varieties.

Cross, W. E., & Fawcett, G. L.

(87) La Enfermedad del "Mosaico" en España. Rev. Tuc., XIV, pp. 80–2; 1923. Interesting correspondence with Planidura Carreras, of Barcelona, in regard to outbreak of Mosaic in Spanish canefields. In case of light or localized infection advise rogueing and establishment of isolated seed gardens, whereas if infection is more or less generalized advise use of *Uba* or other immune canes, or such strongly tolerant varieties as *POJ 36* & *213*.

Cross, W. E. & Harris, W. G.

(88) Deterioration de las Cañas de Semillero de Java después de Cortadas. Rev. Tuc., VII, pp. 219–50; Nov., 1916. An extremely studious and valuable contribution to this subject. The authors conclude that (1) *POJ 36, 213* & *234* and *Uba* suffer a very rapid deterioration upon cutting, (2) these canes should be gotten to factory within 48 hrs. after harvesting, (3) *Uba* suffers most rapid inversion of above varieties, (4) aside from loss of sucrose in these canes due to delayed delivery, the loss of weight is an important factor and (5) degree of inversion is largely dependent on climatic conditions.

Deerr, Noel

(89) Cane Sugar, publisht by Norman Rodger, London, pp. 40–1, 1921. Gives Jeswiet's and Fawcett's descriptions of a number of the *POJ* canes, together with history of their production.

Díaz, Carlos

(90) Poder Calorífico de Algunas Cañas de Azúcar. Universidad de Tucumán (Argentina), Depto. de Investigaciones Agrícolas. No. 7, p. 44; 1918. Emerson calori-

meter tests of frozen *POJ* canes to be used as fuel gave 4,009 calories for *36,* 4,075 for *213* & 4,140 for *234,* determined on a dry basis.

DUREAU, GEORGE

(91) Seedling Canes. Journal des Fabricants de Sucre, Paris, 1916. Reviews a circular of the West Indies Committee giving hist. of seedling production in West Indies and Java and studies work done by Rosenfeld with *POJ* canes in Tucumán Expt. Sta. Agrees with Cross that the introduction into and trial of the Java varieties constituted an epoch-making event in the history of Tucumán Province.

EARLE, F. S.

(92) Recomendaciones sobre el Cultivo de la Caña de Azúcar en Puerto Rico. Estn. Exptl. Insular, Circ. 17, pp. 1–24; 1919. One of the few available publications on cane cultivation on the "Isle of Enchantment."

(93) Varieties of Sugar Cane in Porto Rico. Jour. of Dept. of Agr. & Labor, P. R., III, 2, pp. 15–55; Apr., 1919. Describes *POJ 36* as *J 56, POJ 213* as *J 226* & *POJ 234* as *J 324,* all erroneously.

(94) The Resistance of Cane Varieties to Yellow Stripe or the Mosaic Disease. Ins. Expt. Sta. of P. R., Bull. 19, pp. 1–15; 1919. "The two Java kinds (*36* & *234*), included in the list of selected varieties, are worthy of special mention. They are in no sense immune since they take the disease freely, but they are so tolerant of it or so resistant to its effects that it seems to do them no appreciable damage. Growth is not checked and the foliage is not yellowed, the presence of the disease only being indicated by a faint mottling with different shades of green. No cankers are formed on the canes. These are the two kinds that have come to be planted almost exclusively in the Argentine, where they have replaced the Rayada and the Morada, the kinds formerly planted there."

(95) Eradication as a Means of Control in Sugar-Cane Mosaic or Yellow Stripe. Ins. Expt. Sta. of P. R., Bull. 22, pp. 1–17; 1919. Repts. on one year's highly practical work.

(96) The Year's Experience with Sugar Cane Mosaic or Yellow Stripe Disease. Jour. of the Dept, Agr. of P. R., III, 4, pp. 3–33; Oct., 1919. Gives proper classification of *POJ 36,* which, confused by Deerr's description (erroneous) as green cane, he had previously (93) called *Java 56.*

(97) Sugar Cane Root Disease. Journ. Dept. Agr. of P. R., IV, 1, pp. 1–27; Jan., 1920. As regards comparative resistance test with 171 varieties at Santa Rita, says

of *POJ 36:* "Ratoons stand perfect, condition, best. Almost equally as resistant to root disease as the *Kavangire* (*Uba*). These make a class apart in their almost complete immunity to root disease and in their great ratooning power. *POJ 105* promises to be equally resistant."

(98) El Mosaico de la Caña o Matizado. Est. Expt. Insular de P. R., Circ. 22, pp. 2–9; Abril, 1920. Discusses resistance of *POJ* canes.

(99) Variedades de Caña. Ins. Expt. Sta., P. R., Circ. 23, pp. 1–12; Abril, 1920. History and description of *POJ 36, 105* (*Egyptian*) & *234.*

(100) Las Variedades de Caña en Puerto Rico. Est. Exp. Insular de P. R., Circ. 33, pp. 16–19; No., 1920. Paper presented before the meeting of the Assn. of P. R. Sugar Technologists in Río Piedras, 17th Nov., 1920. Calls attention to remarkable resistance to Mosaic Disease shown by *POJ 36* & *234.*

(101) Sugar Cane Varieties of Porto Rico. II. Jour. Dept. Agr. of P. R., V, 3, pp. 1–141; 1921. Corrects description of *POJ 36* which he had earlier described as *56* & describes *POJ 105.* Notes *POJ 213* as imported from the Argentine by this Station in 1921, but not tested.

EARLE, F. S., *et al.*

(102) Yellow Stripe Investigations (Progress Report). Jour. Dept. Agr. of P. R., III, 4, pp. 1–150; Oct., 1919. In the first paper in this volume Mr. Earle again calls attention to the tolerance of *POJ 36* & *234* to Mosaic.

EASTERBY, H. T.

(103) 33nd Annl. Rept. of the Bureau of Expt. Stations, Queensland, pp. 1–58; 1922. Mentions *POJ 36* & *213* as recently imported from Java to Bundaberg Station.

FAGALDE, LUIS M.

(104) Memoria del Banco de la Provincia de Tucumán, pp. 46–8; 1917. Estimates no. of hect. cane in Prov. of Tucumán at 75,446, of which *POJ 36, 213* & *234* represent 66,487. Calculates yield of *Creole* (*Rayada*) at 15 tns. per hect. and the *POJ* canes at 50.

(105) *Id.,* 1919, pp. 33–5. "For the crop of 1920 we can calculate that the whole 80,000 hectares in cane in the Province will be replanted with the best Java varieties . . . If a few small plantings of the native canes remain they need not be taken into consideration, as they will not be of sufficient importance to exercise any influence on the general calculations . . . . The 112,289 hectares of *Creole* (*Rayada*) canes which existed in 1914 have now entirely disappeared."

FARNELL, R. G. W.

(106) Scientific Research in Connection with the Sugar Industry. I. S. J., XXVI; pp. 303–7; June, 1924. Paper read before the West Indian Agr. Conference, 30th Jan., 1924. "Mr. Bovell calculates that simply by replacing the White Transparent variety by three of his seedlings the planters (of Barbados) have reaped a direct profit of over £4,000,000 within the last eight years. Similarly in Argentine it has been estimated that by the introduction of Java seedlings the planters of Tucumán are saving £500,000 per annum (in costs of cultivation only). In Java the results have been even more striking."

FAWCETT, G. L.

(107) Producción de Caña de la Semilla. Rev. Tuc., V, pp. 451–2; Mar., 1915. In view of important results obtained in Tuc. with *POJ* seedling canes, points out importance of continued attempts to obtain seedling canes bred under Tucumán conditions, which author eventually succeeded in doing.

(108) Las Enfermedades de las Raíces de la Caña. Rev. Tuc., VI, pp. 37–8; Jun., 1915. Few root diseases occur in Tucumán. Concludes that importance of *Marasmius* has been over-estimated by cane pathologists, although undoubtedly causes occasional trouble. For control of root disease complex recommends planting of resistant varieties such as *POJ 36* and *213*.

(109) Algunas Descripciones Botánicas de las Variedades de Java y Otras Cañas. Rev. Tuc., VI, pp. 509–23; May., 1916. Valuable original descriptions, according to Jeswiet system, of *POJ 234*, *36*, *213* & *105* (as *Ambar de Egipto*).

(110) La Descripción de Variedades de Caña. Rev. Tuc., VII, pp. 351–3; Ene., 1917. Calls attention to importance of proper description and classification of cane varieties in order to avoid large losses to planters through the planting of inferior canes which look like proven better varieties. Reviews work along this line in Java by Soltwedel, Benecke, Kobus (the originator of the *POJ* canes) and latterly by Jeswiet.

(111) La Identificación de las Variedades de Java y Otras Cañas. Rev. Tuc., VII. pp. 424–31; Mar., 1917. As previous descriptions have seemed complicated to the planters, considers in this article only the simplest and most noticeable characteristics of the varieties.

(112) Algunas Mutaciones Normales y Anormales de la Caña de Azúcar. Rev. Tuc., VIII, pp. 33–40; 1917. Interesting descriptions and cuts of two remarkable mutations of *POJ 36*, with discussion of spot formation in sugar-cane varieties.

(113) Notas. Rev. Tuc., VIII, pp. 81–2; 1917. Discusses recent demonstration of extreme susceptibility of *H 109* to "eye spot" (*Cercospora sacchari* Van Breda de Haan) as an indication of care growers of *POJ* canes in Tucumán should take in reporting any unusual outbreak in their canes.

(114) Hojas Amarillas de Brotes de Caña. Rev. Tuc., VIII, p. 110; 1917. Short note on chlorotic condition of cane leaves, due to defective nutrition. "The *Java POJ 36*, being a variety with light green leaves, shows this chlorotic condition more frequently than the other Java canes."

(115) Algunas Descripciones Autorizadas de Cañas Originales de Java. Rev. Tuc., VIII, pp. 195–214; 1918. Detailed botanical descriptions with cuts, of *POJ 36* & *213*, translated into Spanish from the original Dutch of Dr. Jeswiet. A valuable addition to Spanish literature of subject.

(116) Enfermedades de las Raíces y de las Cepas de la Caña. Rev. Tuc., IX, pp. 97–102; 1918. *POJ 36, 213* & *234*, commonly cultivated in Tucumán, while relatively resistant to root diseases, do suffer to certain extent from their attacks. Considers *POJ 36* most resistant of these three. Advises employment of good cultural methods & rotation of crops from time to time.

(117) Algunas Descripciones Adicionales de Variedades de Caña. Rev. Tuc., IX, pp. 129–52; 1919. Descriptions of *POJ 105* & *234*.

(118) La Obtención de Cañas de Semilla Producida en la Argentina. Rev. Tuc., X, pp. 31–41; 1919. Discusses "the superiority of the canes introduced from Java over those formerly cultivated here" and mentions the plantation of *POJ 36, 213* & *234* made by Rosenfeld in the northern province of Jujuy with the object of obtaining flowers—"the first plantation of cane made by the Expt. Sta. outside of the Province" (of Tucumán). States that the flowers of *POJ 36* & *213* are pollen-sterile, those of *POJ 234* fertile to very small extent and *POJ 105* probably fairly fertile.

(119) La Enfermedad de las Rayas Amarillas en la Caña. Rev. Tuc., X, pp. 46–8; 1919. "In every case the oldest infected leaves of the Java canes possess a dark green color and appear completely sound and normal, not showing the white and yellow areas characteristic of the older infected leaves of other varieties. This fact indicates that the Java canes have a certain degree of resistance to the disease. The yields of the Java canes heavily attacked by Mosaic have been very satisfactory indeed."

(120) Notas Adicionales sobre las Cañas Criollas. Rev. Tuc.,

X, pp. 170–5; 1920. Discusses parentage of female parents of these canes (*Rayada & Morada*).

(121) Notas sobre la Extirpación del Mosaico de la Caña. Rev. Tuc., XI. pp. 74–6. 20. "The Java canes fall into the class which does not seem to suffer from the infection."

(122) Las Primeras Investigaciones sobre el Mosaico en Java. Rev. Tuc., XI, pp. 121–3. 1921. Reviews Kobus' early work in Java."

(123) Notas sobre la Clasificación de la Caña Morada Criolla. Rev. Tuc., XII, pp. 125–7; 1922. Shows that purple creole cane of Tucumán is distinct from *Black Cheribón* of Java, parent with *Chunnee* of *POJ 213*, which he states is "perhaps the best variety in the Province."

(124) Enfermedades de la Caña de Azúcar en Tucumán. Rev. Tuc., XIII, pp. 1–46; 1922. Mentions plant of *POJ 36* & *213* as susceptible to top rot & *POJ 234* both as plant and ratoons. *POJ 36* apparently least affected. Considers *POJ 36* also most resistant of Java canes to Mosaic, *POJ 105* in intermediate grade and the *213* most susceptible. All four resistant to root rot. Discusses windrowing expts. with *POJ 36* & *234*.

(125) La Desinfección de la Caña por la Calefacción. Rev. Tuc., XIII, pp. 205–6; 1923. Interesting rept. on results from expts. to determine effect of water at from 48 to 50 deg. C. on Mosaic infection in *POJ 213*. "The procedure, as can be seen, had an entirely negative effect on the Mosaic. The temperature which is capable of destroying the eyes appears to be close to 50 degrees C." X-ray expts. gave negative results also.

(126) El Mosaico de la Caña de Azúcar. Rev. Tuc., XIV, pp. 5–8; 1923. "Some varieties do not seem particularly affected by the disease. The varieties *POJ 213* & *36* . . . are notable in this respect . . . . Despite their heavy infection with Mosaic they are still cultivated with very good results. The majority of the other varieties which have been tried here . . . have proven to possess very little resistance to the disease, for which reason their cultivation has been discontinued."

(127) Algunas Notas sobre el Efecto del Frío sobre las Yemas de la Caña. Rev. Tuc., XIV, pp. 67–73; 1923. An exceptionally interesting and original study of the effect of freezes on the eyes and heart buds of cane, *POJ 213* being used in the expts. with controlled temperatures of various intensities and durations below the freezing point. Concludes that (1) a temperature of around—3 degrees C. is required to kill the mature eyes, (2) the sprouts are less resistant to cold than

mature eyes, 1½ to 2 degrees C. below zero, according to their stage of development, destroying them, and (3) the black color on the interior of the heart bud frequently found after low temperatures is due to prolonged exposure to temperatures somewhat above those required to kill the cane—for example, several hours' exposure to a temp. around 1½ degree below zero Centigrade.

(128) La Enfermedad de las Raíces en la Caña de Azúcar. La Hacienda, Buffalo, N. Y., XIX, 6, pp. 174–5; Jun., 1924. "The planting of sugar cane of the varieties of Java in the infected soils will be found very advantageous."

GARBIN, GEROLAMO

(129) L'Industria dello Zucchero di Canna. Pubblicato per cura della Ditta Cav. Enrico Toniolo, Milano; 1924. Cites use of Java canes in revolutionizing Argentine sugar industry.

GARCÍA, TUBAL C.

(130) El Costo y la Ganancia de Azúcar. Sugar, N. Y., XXV, 8 & 9, pp. 446–7 & 506–7; Aug. & Sept., 1923. A thesis presented to the Faculty of Economic Sciences of the U. of Buenos Aires, in which the author analyses cheaper cost of sugar production in Tucumán, through use of *POJ* seedlings.

GRUNAUER, L.

(131) Algunos Análisis de la Caña de Lules, 1913. Rev. Tuc., V, pp. 53–6; Jul., 1914. A miscellaneous lot of analyses from one of the best cane sections in Tucumán province of some *Java* seedlings, *D 74* and *Rayada* cane.

GUZMÁN, ALFREDO

(132) La Estación Exptl. y su Utilidad. Rev. Tuc., III, pp. 243–7; Nov., 1912. Letter from Pres. of the Board of Tuc. Sugar Expt. Sta. to the Secretary of the Buenos Aires "Sugar Center" calling attention to work of Expt. Sta. "Consider only the results obtained from some of the Java canes and you will recognize that we have a perfect right to feel very optimistic."

(133) La Cuestión Azucarera. "La Nación" de Buenos Aires, 27 Oct., 1916. An interview with the Pres. of the Tuc. Agr. Expt. Sta. Board. "Happily, and thanks to the investigations carried on by the provincial expt. sta. for many years past, varieties have been found and proven which seem to combine all the desired conditions, as regards agricultural as well as industrial yield, and this year the sugar men and planters have intensi-

fied their efforts to such an extent that practically all the cane fields which were in bad condition are now replanted with these varieties."

HALL, J. A.

(134) Los Problemas Azucareros. El Mundo Azucarero, Habana; Sept., 1914. Reviews work of expt. stations of Tucumán, Perú, Jamaica, Cuba and Louisiana, which he had recently had occasion to visit. Speaking of promising results with *POJ* canes in Tucumán, concludes: "The studies and experiments already realized in the Tucumán Expt. Sta. give promise of very shortly reimbursing the sugar manufacturers and planters for all the expense involved in the establishment and maintenance of that institution—and not only reimburse the funds invested but pay a handsome dividend on the investment . . . Such results can be looked upon with justifiable pride by the experts of the Station."

(135) Observaciones acerca de los Efectos de la Brotación Prematura de la Caña de Azúcar. Mundo Azucarero; 1914. Review of work carried on at Tucumán Sugar Expt. Sta. along this line. Gives complete analyses of *POJ 36* & *234* during crop of 1913.

HAMAKERS, CARLOS R.

(136) Plantaciones o Criaderos de Semilla de Caña en la Montaña. Rev. Tuc., III, pp. 257–61; Nov., 1912. Advises the establishment of seed gardens in Tucumán foot hills, similar to those employed in Java, in order to obtain selected cane each season for the plantations of the *POJ* canes then giving such promising results in the Province.

HAYS, W. M.

(137) Informe sobre la Estación Exptl. Agrícola de Tucumán. Rev. Tuc., V, pp. 139–50; Sept., 1914. Reports, as Consulting Technologist to Tucumán Government, on past and future work of Tuc. Sugar Expt. Sta. and its relation to recently founded University of Tucumán. Points out remarkable results already obtained from the *POJ* canes and discusses usefulness of various distinct lines of investigation to the Province. Appends list of 117 projects under investigation at Sta.

JESWIET, J.

(138) Beschrijving der soorten van het Suikerriet. Med., VI, 7 & 8; 1916. Probably the work of most importance to date on technical descriptions of cane varieties, being extensive and detailed. Follows more or less same system of description employed by his predecessors. Soltwedel, Beinecke & Kobus, this being based on

vegetative characteristics of plant cane 4–6 months old or the upper part of mature canes.

(139) Id., No. 12; 1917. Publishes detailed original descriptions of *POJ 36* & *213*, with illustrations. A most useful contribution to literature of this subject.

JOHNSTON, JNO. R.

(140) The Mosaic Disease of Sugar Cane in 1923. Published by the Agr. Research Dept. of the United Fruit Co.; pp. 1–35; Dec., 1923. "*Java 36* (*POJ*) is also highly resistant."

JONES, T. H.

(141) The Sugar-Cane Moth Stalk Borer. Expt. Sta. of Sug. Plan. Assn. of P. R., Bull. 12; March, 1915. Reviews Van Dine's work and adds much additional data. Calculates loss caused to P. R. sugar producers in 1915 by *Diatraea* at 32,700 tons of sugar.

KERR, E. W.

(142) Fiber Content of Sugar Cane. Sugar, N. Y.; 1915. Calls attention to importance of high-fiber canes for furnishing fuel in subtropical countries. Gives analyses of *POJ* canes in Tucumán and comments on high fiber content of all the promising ones. Considers the adoption of these canes a step forward, not only agriculturally but mechanically.

KOBUS, J. D.

(143) Vergelijkende proeven omtrent gelestrepenziekte. Med., No. 12, pp. 319–42; 1908. First practical studies of Mosaic Disease by the man who by means of crosses produced the *POJ* seedlings. Kobus arrived at the conclusion that the disease manifests itself with varying virulence, citing the example of *Java 247* (*B*), which is stunted and weakened by the disease, while *POJ 36* represents the other extreme of high resistance. Often the latter did not seem to undergo any decrease in yield on acct. of Mosaic, although this declaration does not harmonize with a table of yields which he presents in this paper.

(148) Cane Seedlings in Java. I. S. J., XI, p. 314; 1909. Interesting review of seedling work in Java to date.

KOBUS, J. D., *et al.*

(145) La Caña de Java. Rev. Azucarera, Buenos Aires, XIV, pp. 182–4; Sept., 1916. An interesting and almost forgotten little fragment of history of first introduction of the Java seedlings into Tucumán, first suggested to Gov. Luís Nougués by Dr. Kobus while Director of the Expt. Sta. in Java. Extracts from several of Kobus' letters from 1907 to 1909, together with those

from Gov. Nougués, are given. In speaking of this series of canes, Kobus wrote: "We have in our exptl. fields a series of new cane varieties from which I anticipate a considerable increase in Java sugar production."

MAROTTA, F. PEDRO

(146) Observaciones sobre los Experimentos Realizados en la Est. Exptl. Agrícola con Variedades de Caña. Bol. del Ministerio Nacional de Agricultura, Buenos Aires; 1914. Extremely superficial review of the Tucumán variety work.

(147) El Proteccionisma a la Industria Azucarera por la Ley 8877. Bol. del Ministerio Nacl. de Agr., Bs. Aires, XX, 7 & 8; 1916. Comments on importance of Rosenfeld's "Ten Best Canes in Tucumán." (166). "The canes recommended, then, are the *Java POJ 36, 213, 234* & *139*, which give good yields and are early maturers, with the exception of the *139*, which is a bit late. All have good purities and mfg. value."

MAY, D. W.

(148) Rept. of P. R. Agr. Expt. Sta., 1920. Speaks of the *POJ* varieties as partially immune and "making good growth and producing large yields in spite of Mosaic."

NATTA MAGLIONI, JOSÉ V.

(149) Fomento Agrícola del Chaco. Depto. Nacional de Agra., B. Aires; 1917. "The Java varieties are very much in demand in Tucumán and we fear that little seed can be obtained for use outside the province, since they are destined to totally supplant the Creole canes in that province on account of their outstanding good qualities definitely demonstrated experimentally in that sugar region."

NOUGUES HNOS. *et al.*

(150) El Cultivo de Nuevas Variedades de Caña. Revista Azucarera, Buenos Aires; Nov., 1912. Various replies to a questionnaire sent out by the "Buenos Aires Sugar Center" asking for repts. on results of expts. with new varieties. It is interesting to note that only a few centrals replied that they were cultivating any material extension of the *POJ* canes at that time.

PADILLA, ERNESTO E.

(151) Governor's First Message to Tucumán Legislature; April, 1913. Referring to promising results from *POJ* canes in the Agr. Expt. Sta., says: "Results of the experiments indicate that we are at the initiation of a great evolution in our agricultural industry which will increase our yields and greatly reduce the cost of the manufactured product."

(152) Final Message to Legislature; 2nd April, 1917. "Thanks to the foresight of Gov. Nougués in 1908, seconded ably by the initiative of some of our most enterprising citizens, and later by the work of the Expt. Station, it has been possible to largely increase the plantations of the Java varieties, which promise to give yields double those obtained from the *Rayada* cane on the same area."

(153) Debate on Sugar Tariffs. Argentine Cong. Record; 1917. By planting the Java canes the cost of production is considerably reduced, since these canes develop more quickly and require less cultivation and, consequently, less expense than do the other varieties generally cultivated."

(154) La Cuestión Azucarera. Arg. Cong. Record; 11th Aug., 1920. "The Argentine is the only country in the world which, after almost entirely losing its canefields through a grave agricultural crisis, has recovered from such a blow in so short a time. The industry has come to life again through the employment of the Java canes studied in its experiment station, wisely provided by the intelligent intuition of Governor Luis Nougués."

PADILLA, MIGUEL M.

(155) La Crisis del Azúcar. La Prensa, Buenos Aires; 5th Dec., 1916. "As regards the agricultural phase of the problem, the Argentine industry is at present in a state of evolution. When symptoms of degeneration began to be noted in what is known as the *Creole* cane, which is the variety which has always been cultivated in this country, the planters began to replace this old variety by new ones from Java, the agricultural and industrial yields of which have turned out to be about double those of the native cane.

PAIGE, R. L.

(156) The Future of Uba Cane in Porto Rico. Memoirs of the Assn. of Sugar Technologists of P. R.; 17th June, 1922. Mentions *POJ 36* & *105* as promising canes.

(157) Notes on Some Imported Cane Varieties in Porto Rico. Facts about Sugar, XV, p. 420; 1922. Reports a yield from Guánica of 38 tons per acre for first ratoons of *POJ 36* in 1922, with 15.2% sucrose in juice.

PEÑA, SOLANO

(158) Industria Azucarera; Realidades y Esperanzas. Rev. Tuc., III, pp. 534–6; May, 1913. Calls attention to low field yields in Tucumán as compared with other sugar-producing countries and predicts doubling of Tucumán yields as the *Java POJ* canes are extended

over province. This prediction was realized within five years.

PRINSEN-GEERLIGS, H. C.

(159) Cane Sugar and Its Manufacture. Published by Norman Rodger, London, pp. 1–350; 1909. A standard reference work of great value.

(160) Tratado de la Fabricación del Azúcar de Caña. Published by J. H. de Bussey, Amsterdam, pp. 1–337; 1910. Translation of (159) by Dr. Nicolás van Gorkum, Engineer in the service of the General Sugar Society of Spain.

(161) De Rietsuikerindustrie in de Verschillende Landen van Productie. Vol. IV of Handboek ten dienste van de Suikerriet-Cultuur en de Rietsuiker-Fabricage op Java, published by J. H. de Bussey, Amstdm., pp. 1–416; 1911. Historical, technical and statistical review of the world's cane-sugar industry.

REPETTO, DEPUTY

(162) Sugar Debate. Argentine Cong. Recd., 24th Jan., 1917. Quotes Rosenfeld on comparative productivity in Java and Tucumán, giving figures on area of *POJ* canes planted in the latter and time necessary for complete renovation with these of Tucumán cane area.

ROSENFELD, ARTHUR H.

(163) Una Enfermedad de las Raíces de la Caña. Rev. Tuc., I, 9, pp. 18–20; Feb., 1911. Records *Marasmius sacchari* on roots of some *POJ* canes.

(164) El Trabajo de la Estación. Rev. Tuc., I, 9, pp. 44–7; Feb., 1911. "At the present time the Station is experimenting with 211 varieties of sugar cane from Louisiana, Barbados, Cuba, Porto Rico, Demerara, Java, Spain, Brazil, Argentine and other countries."

(165) La Propagación de Nuevas Variedades de Caña de Semilla. Rev. Tuc., III, pp. 53–66; Jul., 1912. Critical review of Agee's paper on this subject before La. Sugar Planters' Assn. on 13th April, 1911.

(166) Diez de las Cañas más Prometedoras que Están Experimentándose en la Estación Experiemntal. Rev. Tuc., III, pp. 109–33; Ago., 1912. Lecture given before the Sarmiento Society in Tucumán. Ranks *POJ 36*, *213* & *234* amongst the ten most promising of the 250-odd varieties tried.

(167) La Caña Java *POJ 228* Rev. Tuc., III, pp. 139–42; Sept., 1912. Critical exptl. comparison of *POJ 228* with *36*, *213* & *234*. "*POJ 228* was inferior in every way to the other varieties—in chemical analysis as well as in yield of cane."

(168) The Most Promising Varieties of Cane under Trial at

the Tucumán Expt. Station. I. S. J., XVI, pp. 12–23; 1914. Contains in English practically the same subject matter as (166).

(169) Las Cañas de Java en la Estación Experimental Agrícola. La Gaceta, Tucumán; May., 1914. Comments on breakage of a mill roll said to have been due to high fiber content of *POJ 234* being ground at time. "It is positively ridiculous to take the attitude that these high-fiber canes cannot be successfully ground in the modern Tucumán centrals . . . The high fiber content of some of these canes does not in any sense constitute an obstacle to their employment . . . In a simple mechanical problem such as this is Tucumán ought to be able to find the same solution which has been encountered by any other sugar country." Gives fiber content of *POJ 36, 213* & *234* and shows that many Java mills grind continuously canes with higher fiber content than any of these.

(170) Maduración de las Cañas Extranjeras. Rev. Tuc., IV, pp. 527–9; 1914. Analyses made in April, 1914, some two months before initiation of crop (corresponding to October in P. R.), showed good stages of maturity for some of the most promising *POJ* canes. *POJ 234* again demonstrated itself a very early maturer with 86% purity and 14% suc. in juice. *POJ 36* showed 80.4% and 13.8%. "The *Java 234* & *36* (*POJ*) seem to possess in high degree the characteristic of early maturity which is so outstanding in our native canes."

(171) Discurso en Reunión de Plantadores, 14 May., 1914, Rev. Tuc., V, pp. 1–4; Jun., 1914. Calls attention to need of caution and patience in variety expts., as well as to positive danger of jumping at conclusions from a few years' results. "This point should be clearly demonstrated by the fact that, almost without exception, the new varieties of cane which gave us the most promising results the first year of their trial are not today, after four years of careful and accurate investigation from every standpoint, ... those we can recommend for replacing the native canes."

(172) Las Cañas de Java y su Contenido de Sacarosa. Rev. Tuc., V, pp. 199–207; Oct., 1914. Various comparative analyses of *POJ 36, 213*, & *234* with native canes in Tucumán during 1914 crop. *POJ 234* appears in one analysis from Expt. Sta. with 20% sucrose in juice and in another from San Pablo with 19½%. "The analyses of the Java canes have turned out relatively as good as those of the canes of the country."

(173) Ensayos con Abonos durante Cuatro Años. Rev. Tuc., V, 8, pp. 323–61; Jan., 1915. Uniformly negative results from comm. fertilizer applications to *Rayada* cane

indicate that Mosaic Disease has so weakened cane that it does not respond to fertilization.

(174) Memoria de la Estación Exptl. Correspondiente al Año 1914. Rev. Tuc., V, pp. 415–37; Mar., 1915. Short review of work of Station with varieties, especially the *POJ canes,* during year.

(175) Resultados de Cinco Años de Experimentación con Variedades de Caña. Rev. Tuc., VI, 6, pp. 231–78; Nov., 1915. "*POJ 36,* on account of the characteristics already discussed, appears to be the cane destined to replace the *Creole* (*Rayada*) cane in our Province, the *POJ 213* & *234* . . . . following in the order of their mention."

(176) Plan del Campo Experimental. Estn. Exptl. Agr. de Tuc., Circ. Especial; 1915–16. Notes on various expts. with *POJ* canes and diagram of exptl. plats.

(177) Maduración de las Cañas Extranjeras. Rev. Tuc., VI, 434–6; Mar., 1916. Analyses of *POJ 36, 213* & *234* made latter part of April, 1916. "The analyses . . . show . . . very respectable percentages of sugar in the juices of these varieties which we now know to be of early maturity and enable us to predict for the coming crop at least normal purities."

(178) Identificación de las Cañas de Java. Rev. Tuc., VI, p. 437; Mar., 1916. Planters who desire to propagate *POJ 36, 213* & *234* should be certain that seed they obtain is of these varieties and if in doubt should send specimens to Expt. Sta. for identification.

(179) La Caña Kavangire. La Gaceta, Tucumán; 15 Abril, 1916. Calls atention to confusion amongst certain planters in identification of *Kavangire* (*Uba*) & *POJ 234.* "The planter who purchases *Uba* thinking that he is obaining *POJ 234,* paying the price demanded for the latter, is losing money."

(180) La Estación Experimental Agrícola de Tucumán en el Centenario de la Independencia Argentina. Rev. Tuc., VII, pp. 1–82; 1916. "The value of these investigations has been recognized both within and without the country, not the least important of these being those which have enabled the Station to recommend to the planters a series of cane varieties which give far superior results to those commonly employed, as well as the best methods of planting, seed selection, cultivation, etc."

(181) Some Epoch-Making Experiments in the Argentine: The Java Canes in Tucumán. Sugar, N. Y.; Dec., 1917. Discussion of results with Java seedlings in Tucumán and their bearing on the Argentine sugar industry.

(182) Some Remarks on the Tucumán Sugar Industry. Published by American Commercial Club, Buenos Aires;

Dec., 1918. An address before the Comm. Club, covering more or less same ground as (181).

(183) Estudios Gráficos de las Diversas Variedades de Java en las Colonias de Santa Ana. Rev. Tuc., X, 2, pp. 57–8; 1919. "According to yield and analyses there is little to choose between the *36* and *213*, the former probably being preferable only on account of its erect growth, small amount of lodging and easier stripping."

(184) La Estación Experimental de Tucumán; Retrospecto de sus Trabajos. Revista Azucarera, Buenos Aires, XVII, pp. 305–9; Oct., 1919. "In the present crop 90% of the cane ground in the Province is of the Java varieties."

(185) What the Tucumán Expt. Station has Done for the Argentine Sugar Industry. I. S. J., XXI, pp. 488–93; 1919. Covers in English largely the same ground as (184).

(186) Some notes on the Tucumán Sugar Industry. I. S. J., XXI, pp. 606–8; 1919. Brief description of climate and short history of sugar industry in that Province up to the time of the replacement of the commonly grown canes by the *POJ*.

(187) Kavangire—Porto Rico's Mosaic-Resisting Cane. I. S. J., XXII, pp. 26–33; 1910. Considers that thinness of *Uba* and *POJ* varieties does not constitute an insuperable objection to their adoption. "The thin, rapid-growing, but not at all aestherically appearing *POJ 36* & *213* . . . have been universally adopted in Tucumán, only a few rows of native cane being seen today, carefully guarded and nursed as an invalid might be by the friends of his youth."

(188) La Caña Kavangire en Tucumán y Puerto Rico. Rev. Azucarera. Buenos Aires, XVIII, pp. 146–8; May, 1920. Contains in Spanish practically same subject-matter as (187).

(189) The Argentine Sugar Industry. I. S. J., XXII, pp. 388–94; July, 1920. Mentions tremendous impulse given Arg. sugar industry by *POJ 36* & *213*.

(190) Power Cultivation of Sugar Cane. I. S. J., XXII, pp. 499–501; Sept., 1920. Tractor cultivation of *POJ 36* & *213*, with a number of cuts of methods and machinery employed.

(191) The Question of the Distance between Cane Rows. I. S. J., XXII, pp. 558–65 & 629–35; Oct. & Nov., 1920. A rather detailed study of results obtained in various parts of the world, including those obtained at the Tucumán Expt. Sta. with native canes and with *POJ* ones later employed as basis of experimentation.

(192) The Java Canes in Tucumán. I. S. J., XXII, pp. 681–3; Dec., 1920. Gives results obtained at Ingenio Santa

Ana with *POJ 36* & *213* on very large scale, these results covering over a thousand acres.

(193) The Question of the Distance Between Cane Rows. I. S. J., XXIV, pp. 72–6; 1922. Bringing (191) up to date.

(194) Lo que la Estación Exptl. de Tucumán ha Hecho por la Industria Azucarera. La Hacienda, Buffalo, pp. 291–6; Oct., 1922. History of the work of the Tucumán Station with varieties and calculations of money value of the substitution of the native canes in that Province by the *POJ* varieties recommended by the Station.

(195) La Caña Kavangire. La Hacienda, Buffalo, pp. 131–4 & 169–72; May & Jun., 1923. Stresses point that, just as high fiber content of *POJ* canes in Tucumán did not prevent their universal adoption there, this factor should not weigh too heavily in the balance against the use of *Uba* cane in Porto Rico.

(196) A Beneficial Aspect of the Sugar-Cane Mosaic Disease. I. S. J., XXVI, pp. 191–5; Apr., 1924. "In the heaviest-infected districts along the west and northwest coast (of P. R.) . . . the tolerant *POJ 36, 105* and *213* are being employed on a large scale with most promising results."

(197) Aspecto Beneficioso del Matizado de la Caña de Azúcar. La Crónica Comercial y Financiera de Cuba, I, 5, pp. 7–9; May 1924. Spanish translation by C. A. Figueroa of (196).

Rosenfeld, Arthur H., & Barber, T. C.

(198) Trabajos de las Sub-Estaciones, 1912–13. Rev. Tuc., IV, pp. 495–514; 1914. At San Pablo *POJ 36* gave 113½ tons of cane per hectare and the *POJ* 213 yielded 95½. At Monte Bello *POJ 36* gave 85 tons and the *POJ 213* 75 tons per hect. In Manantial third ratoons of *POJ 213* yielded 106 tons p. hect.

(199) El Gusano Chupador de la Caña de Azúcar. Rev. Tuc., IV, pp. 229–366; 1913–14. "The moth-borer (*Diatraea*) can be considerably reduced in its damage . . . by gradually substituting the harder and thinner varieties of cane . . . such as some of the Java canes in which borer infestation is always low."

Sánchez, Julio

(200) Informe del Agrónomo Regional. Ministerio Nacional de Agricultura; 1917. Rept. on visit to Centrals "Esperanza" & "Ledesma" in the Prov. of Jujuy, considerably north of Tucumán. From "Esperanza" cites following yields of cane per hect.: *Rayada* 37½; *POJ 36* & *213*, 90; *POJ 234*, 75. Recommends similar trials at "Ledesma".

(201) Informe del Agrónomo Regional al Min. Nacl. de Agra., Buenos Aires. Industria Azucarera, Bs. Aires, XXIX, 365, p. 153; 1924. Regional Agronomist for the Northern Province of Jujuy reports that cane now grown in that province consists 'almost entirely of Java canes."

SIMOIS, DOMINGO L.

(202) Sobre la Caña Tucumana. Argentine Cong. Rec.; 1917. During debate on sugar tariff Senator Padilla of Tucumán quoted from tlgm. from Director Simois, of the National Sugar School in Tucumán, to Sen. Camaño, as follows: "We recommend . . . the cropping . . . of . . . large extensions of Java cane . . . We have been able to establish yields of 100 tons per hectare."

SMITH, ERWIN F.

(203) Bacteria in Relation to Plant Diseases, Vol. III, p. 72; 1914. Mentions stimulus of Sereh ravages to production of *POJ* seedlings.

SNYDER, W. P.

(204) Report of Assistant in Plant Breeding. Rept. P. R. Agr. Expt. Sta. for 1919. Repts. germ. of seed from *POJ 36* & *234* as very poor and the damage caused by "abundant" occurrence of Mosaic on *POJ 36* as "slight" & *POJ 234* as "very serious."

SNYDER & SALDAÑA

(205) Report of the Assistant in Plant Breeding & Horticulture. Rept. of the P. R. Agr. Expt. Sta. for 1921, pp. 16–18; Sept. 1922. The only mention found anywhere of seedlings of *POJ 36*, which is generally found infertile.

STEVENSON, J. A.

(206) The Mottling or Yellow-Stripe Disease of Sugar Cane. Jour. Dept. Agr. of P. R., III, 3, pp. 3–76; July, 1919. Mentions letter from Fawcett reporting resistance of the *POJ* varieties. Refers erroneously to *POJ 36* as *J 856*.

TEMPANY, H. A.

(207) Experiments with Varieties of Sugar Cane, 1920–22, Together with a Summary of Results from 1917 to 1922. Mauritius Dept. Agr., Bull. 30, Gen. Ser.; 1924. As results of expts. with both plants and ratoons during this period, the following varieties are picked out as more or less suitable for cult. on some scale: *D 109, B 6308, B 6450, POJ 213* and 12 local varieties.

TERAN, JUAN B.

(208) La Universidad y la Vida. Lectures of the Rector of the Univ. of Tucumán collected in book form, pp. 1–50;

1921. "We have had in Tucumán some very eloquent experience as to the significance of technical work in Agriculture which serves as a basis with which to gauge its vast possibilities; 3,500 acres of new varieties (*POJ 36, 213 & 234*) of proven canes will in four or five years more entirely take the place of the old varieties. This transformation will probably signify the cutting in half of the cost of our raw sugar material."

VAN DINE, D. L.

(209) Damage to Sugar-Cane Juice by the Moth Stalk-Borer. P. R. Sug. Planters' Expt. Sta., Circ. 1, pp. 1–11; 1912. Estimates direct loss in sugar per acre from reduced value of juice due to borer attacks at 670 lbs. per acre for P. R.

WALE, J. H.

(210) Los Efectos de las Recientes Heladas sobre la Caña de Java. Rev. Tuc., VI, p. 12; Jun., 1915. "It has always been recognized that the Java canes *POJ 36, 213, & 234* are more resistant to the effects of frosts than are the native canes."

(211) Informe de las Subestaciones, Año 1915. Rev. Tuc., VI, pp. 279–96; Dic., 1915. In Monte Bello the second ratoon crop showed 8 tons cane per hect. for the *Rayada*, 61 tons for *POJ 36*, 53½ tons for *POJ 213* & 33 tons for *POJ 234*. In San Pablo as second ratoons the *Rayada* gave 40 tons; the *POJ 36* gave 101, the *POJ 105* gave 69 tons, the *POJ 213* gave 70 tons and the *POJ 234* gave 69 tons. The *POJ 105*, however, showed but 8.69% sucrose in juice, while the *POJ 234*, giving the same field yield, analyzed 14.26%. In Aguilares *POJ 213* showed up best of *POJ* varieties tried as first ratoons with 74 tons cane and almost 3 tons sugar per hectare in a very unfavorable year.

WESTERKAMP, J. F.

(21) Las Cañas Extranjeras en Jujuy. Rev. Tuc., V, pp. 103–5; Ago., 1914. Two interesting letters giving data on an exptl. pltg. of *POJ 36, 213 & 234* at Ingenio Esperanza in the northern province of Jujuy, Argentine. "These canes possess the valuable characteristic of very rapid growth even with a small amount of irrigation water and appear to be well adapted to the drier lands."

WILBRINK & LEDEBOUR

(213) Bijdrage tot de Kennis van der Gelestrepenziekte. Med., No. 39, pp. 433–95; 1910. Interesting statement that seedlings obtained from seed-heads of infected canes are clean.

ZERBAN, F.

(214) Advertencia Respecto a la Importación de Nuevas Variedades de Caña. Rev. Tuc., I, 1, pp. 16–7; Jun., 1910. Mentions early introduction of *POJ* canes into Tucumán & calls attention to danger of introducing pests and diseases if importations are not properly inspected by competent authorities.

ZERBAN, F., & ROSENFELD, ARTHUR H.

(215) ¿Cómo puede mejorarse la Producción y Calidad de la Caña? Rev. Tuc., I, 3 & 4, pp. 1–16; Ago. & Sept., 1910. Discuss early production of seedling canes in Barbados and Java.

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By

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